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THE NIAGARA POWER PLANT OF THE ELECTRICAL DEVELOPMENT COMPANY OF ONTARIO.

I.

DESCRIPTION OF DESIGN AND STRUCTURES.

The main object of the Electrical Development Co. of Ontario is to carry the power of Niagara 78.5 miles to a market in the city of Toronto by electrical transmission. Incidentally the company will develop a manufacturing town on the Chippewa River about 3½ miles from Niagara Falls; will connect Toronto and Niagara Falls with a high speed electric railway on its own right of way, and will give the city of Hamilton and the smaller towns along its line all the advantages of cheap and plentiful electric power for industrial purposes. The plans for all of this work are well advanced and much of the construction work has been completed. Another year will see the great power plant at Niagara Falls in operation and the transmission line completed; the high speed electric railway has been built from Toronto to Hamilton. The new manufacturing town will be a matter of slower development, but it is an uncertainty in no other respect.

The first official step toward the consummation of these joint enterprises was the incorporation by the Canadian Parliament in May, 1902, of the Toronto & Niagara Power Co., with authority to generate and transmit electric power within the Province of Ontario. The authorized capital stock was $3,000,000 and the authorized bond issue was $1,500,000. As the plans of this company developed it was found that a much larger issue of bonds was required to carry them out. This discovery was made too late to have the original act amended at the session of the Parliament of 1902-3; neither was it expedient to wait a year, until Parliament convened again, for power to go ahead with the plans. As a solution of the problem a charter incorporating the Electrical Development Co. of Ontario, Limited, with a share capital of $6,000,000 and a legalized bond issue of $10,000,000, was secured from the Ontario Provincial Government, pursuant to the Joint Stock Companies Act, on Feb. 18, 1903. Meanwhile, on Jan. 29, 1903, Messrs. William Mackenzie, Henry M. Pellatt and Frederic Nicholls had secured franchise rights from the Queen Victoria Niagara Falls Park Commissioners to take water from the Niagara River at Tempest Point for the purpose of generating electricity to the extent of 125,000 E. HP. On March 21, 1903, these franchise rights were acquired by the Electrical Development Co. Subsequently at the same meeting the directors elected officers and appointed Mr. Hugh L. Cooper, M. Am. Soc. C. E., Chief Hydraulic Engineer, and Mr. Beverly R. Value, M. Am. Soc. C. E., Resident Engineer.

POWER HOUSE FOR THE NIAGARA FALLS POWER PLANT OF THE ELECTRICAL DEVELOPMENT CO. OF ONTARIO.

Preliminary studies had been made and the general plans of the power department had been determined upon by Mr. Cooper before the final organization of the Electrical Development Co., on March 21, 1903. With this business settled, however, work was actively begun on the construction plans and preparations for construction.

SELECTION OF SITE.—In considering the selection of a site for the power plant four principal elements were regarded as of fundamental importance. They may be stated as follows: (1) Reliable and sound foundations upon which to build structures; (2) Reliability of water supply; (3) Reliability of the design that is to occupy the foundations and use the water; and (4) Economy of operation and maintenance. In applying these fundamentals to the work in hand it was considered first of all that the construction of a deep vertical wheel pit and the discharge of the water therefrom by the use of a low level tail race tunnel had been demonstrated as successful designs for the geological conditions existing at Niagara so far as feasibility and permanence of construction apply. In respect to reliability of water supply, the chief consideration at Niagara is the handling of the ice that forms along shore or is brought down the river from Lake Erie.

Having settled upon a deep wheel pit and tunnel tail race design, the problem was to select a site giving the proper solidity of foundations and the best facilities for avoiding troubles from ice. To understand the task in all its details it is necessary to state that three power plants were already completed or in process of construction on the Canadian side of the Niagara River. About 500 ft. above the falls there was the power-house of the Niagara Falls Park & River Ry.; above this about a quarter of a mile farther was the power-house and wheel pit of the Canadian Niagara Power Co., while opposite the Dufferin Islands and some 3,500 ft. above the cataract were the forebay, screen house and head gates of the Ontario Power Co. Unless he chose to go beyond the Dufferin Islands, the engineer had only the unoccupied stretch of shore between the Canadian Niagara Power Co.'s power house and the head works of the Ontario Power Co., on which to select a site for the works. Fortunately this available opening for a new works was exceptionally desirable; it gave ledge rock at moderate depths for foundations; it gave a greater head and a shorter tail race than either of the older works having wheel pits and tail race tunnels; it had above it in Tempest Point a natural fender against ice, and it was far enough from the falls to escape the spray and humidity. To get the advantages cited, however, involved two very bold propositions. It would be necessary to lay dry by a cofferdam a large area of river bed in the very midst of the turbulent White Horse Rapids and to drive a tail race tunnel under the river bed to an outlet behind the Horseshoe Falls. The specific gains of this bold plan were a tail race tunnel 400 ft. shorter than the shortest of the two existing tunnels and an operating head at least 10 ft. greater than that of either of the other wheel-pit plants.

The site actually selected and the location of the several essential parts of the plant are shown by the map, Fig. 1.

GENERAL THEORY OF THE DESIGN.—The principle of the design of the works can best be explained by first itemizing the component parts. These are, as shown by Fig. 1: a submerged dam; two lines of submerged arches; a wheel pit; and a tail race tunnel.

The object of the submerged dam is to collect the required water and divert it to conduits leading to the wheel pit. It changes the original rapids in front of the site into a ponded condition and raises the old water level approximately 18 ft. under normal conditions. Connecting with the dam and forming with it a U, opening up-stream, are the lines of submerged arches, the office of which is to divert approaching ice and debris to suction weirs in the lower end of the dam. The submerged arches are really masonry diverting booms, by which the floating ice is caught and diverted from the penstock mouths while the clean water is given free access to them through the submerged arched openings. The idea of the second line of arches is of course that they will intercept such ice and debris as may get past the first line; in addition there are the usual racks or screens over the penstock mouths. The purpose of the two items of the work just mentioned is clear; we have now to consider in how far they promise to perform the objects sought of them.

The power plant as designed calls for enough water to generate 125,000 HP.; assuming the turbines to have an efficiency of only 75%, approximately 700,000 cu. ft. of water per minute must pass the turbine discharges to generate this horsepower. The gathering dam under the most adverse conditions will, it is calculated, seize at least 1,800,000 cu. ft. This is much more water than is needed or than was calculated upon. Owing to the fierce rapids over the area to be occupied by the works it was only possible, before the river bed had been laid dry by cofferdamming, to

make a rough estimate of the depth of water. The actual depth proved some 150% greater than the estimated depth, so that the gathering dam designed for the estimated depth is unnecessarily large as conditions exist. Considering the possibilities of future enlargements of the works and of future drains upon the river and the Great Lakes for power development, canals, etc., it is not regretted, however, that this surplusage of capacity exists.

The efficiency of the design in respect to reducing trouble from ice and debris is based upon the theory that the removal of such obstructions is best accomplished where the structures involved offer the least hindrance to free flow. Owing to the projection of land above the works, the currents here are away from or parallel to the shore rather than in-shore in direction. To ensure the least obstruction to the existing currents means structures as nearly as possible parallel to the shore. It will be observed from the plan, Fig. 1, that the submerged arches are almost exactly parallel to the shore line, while the dam varies from the parallel by the least possible angle and yet serve its purpose; furthermore the dam is a submerged structure with a considerable depth of water over the crest.

Going a step farther it will be noted that besides being designed to interfere as little as possible with the normal current directions, the works are also designed to intensify the natural tendency of the ice floes not to linger or pile up alongshore. Any ice floating in-shore hits the first line of submerged arches. The top of this structure is above water level while the arches are well below the surface. Furthermore the area of the arch openings is so great that the current through them has very little tendency to suck the floes down and through; that is, of the two currents acting on the ice, that inward through the arches is very weak compared with that of the great body of water moving swiftly past down-stream. To increase still further the carrying efficiency of the normal currents, the crest of the dam where it curves to meet the arches is made 3 ft. lower than the normal, thus producing a suction weir. Any ice passing the first line of arches strikes the second line, which acts exactly like the first and also has its suction weir. Finally there are the screens or racks over the penstock openings.

Passing from the dam and masonry diverting booms to the sub-surface design, the principal feature to attract attention is the forking of the tail race tunnel so that it straddles the wheel pit. In both previous Niagara power plants having wheel pits, the pit is located over the tunnel, and the turbines all discharge into the open tunnel at the end of the pit. By the forked arrangement the wheels discharge alternately right and left. Another feature of the construction that is a departure from previous practice at Niagara is the support of the turbines directly upon the solid rock bottom of the pit and the provision of heavy concrete arch intermediate supports for the turbine shaft. Finally it is to be noted that the turbines discharge at the bottoms of the tunnels and parallel to their axes.

The engineers based their choice of these features of the design upon the following reasoning. For a given development of power a shorter wheel pit suffices if the discharge from the wheels can take place on both sides. Also if the discharge from the turbines is at the bottom of the tunnel and in the direction of its axis, instead of at the side and across the axis, there is less chance of eddies and cross-currents and the backing up of the water consequent thereto. Again, the two branch tail race tunnels offer especial facilities for repairs and inspection. It is not to be assumed that machinery can ever be so installed as to remove the necessity of future repair. By the use of the two branch tunnels, it will be possible at any time to close down one half of the station and make the necessary repairs or inspection while the other half of the station continues in operation. The idea of the solid foundations for the wheels and of the heavy masonry arch supports for the shaft bearings is simply to reduce the chance of vibration and correspondingly to minimize the expense of up-keep.

DESCRIPTION OF STRUCTURES.—The structures proper that have been mentioned call for little description in addition to the illustrations.

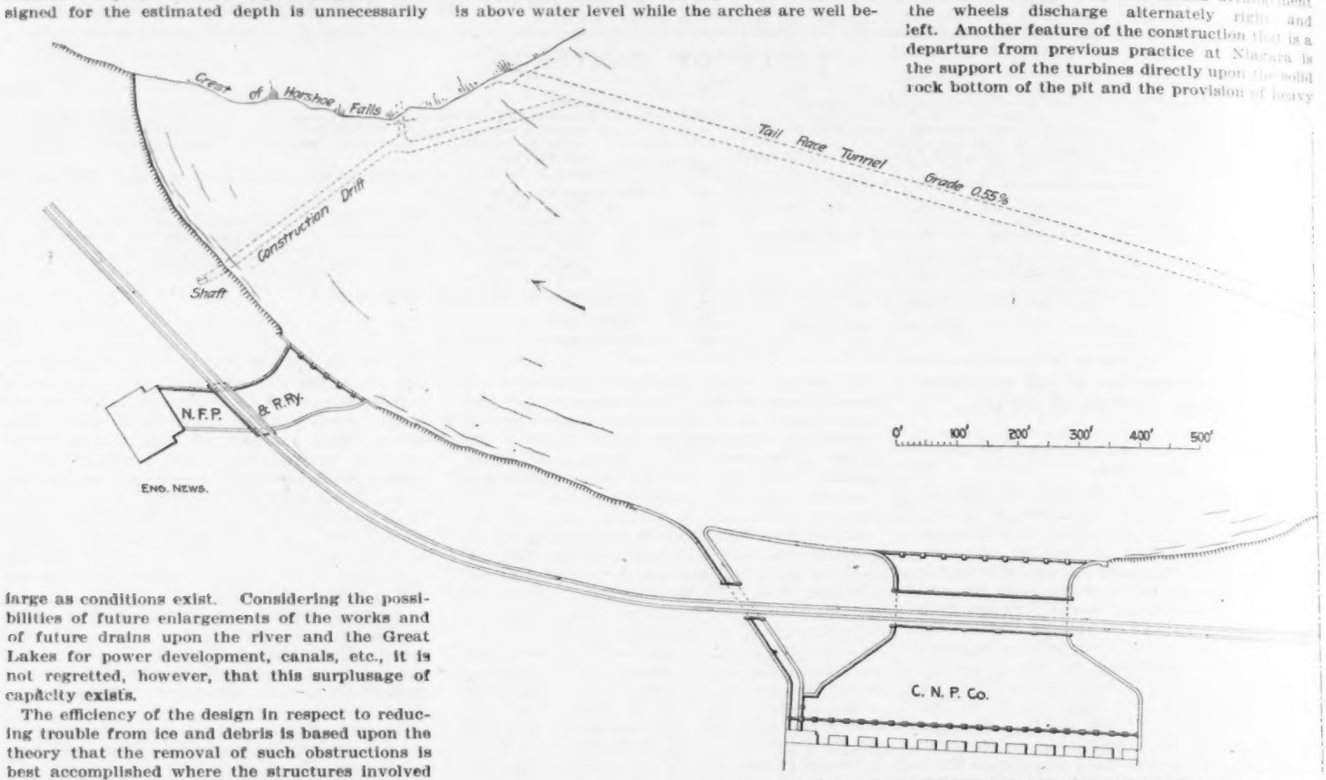


FIG. 1. PLAN OF POWER HOUSE AND WORKS AT NIAGARA

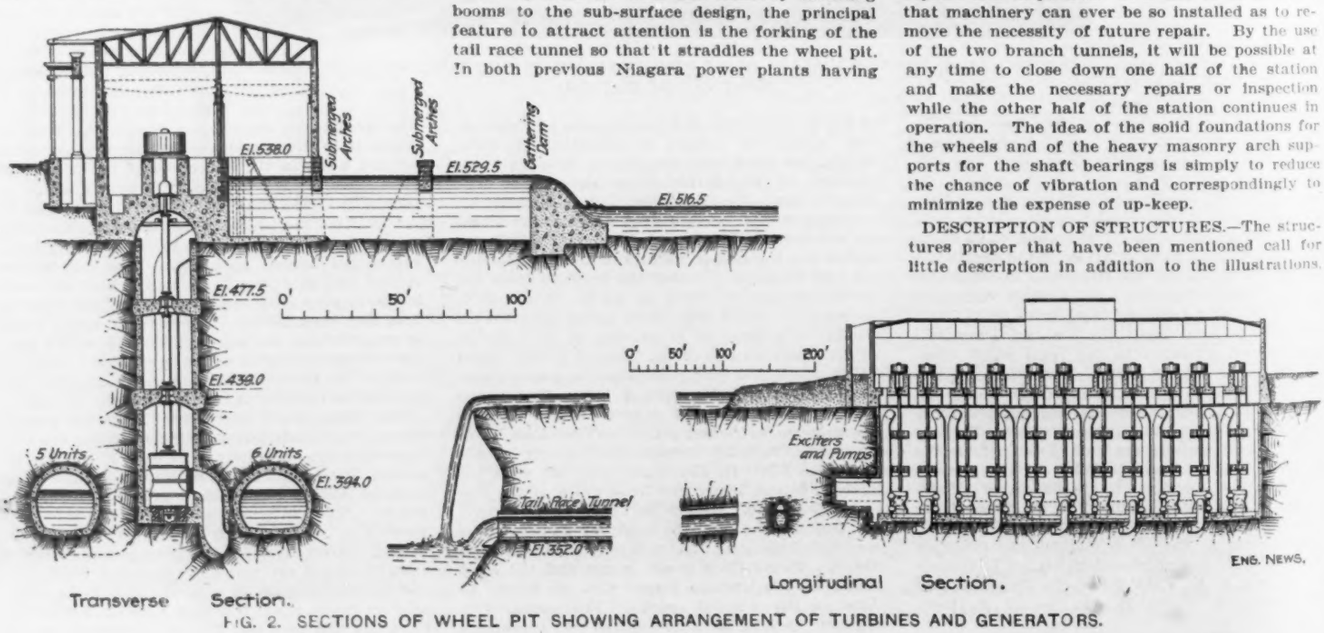
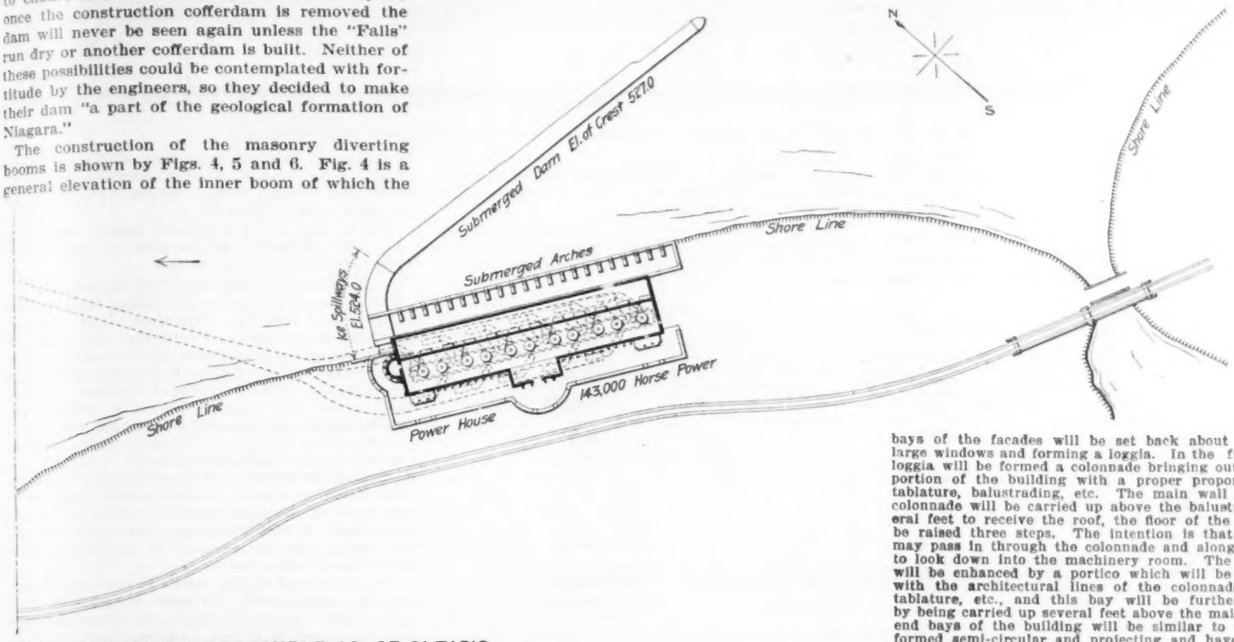


FIG. 2. SECTIONS OF WHEEL PIT SHOWING ARRANGEMENT OF TURBINES AND GENERATORS.

Taking up first the dam, this is a concrete and stone structure set into and founded on ledge rock. Fig. 1 shows this dam in plan and Fig. 2 shows it in cross-section. Fig. 3 is a view of a portion of the structure from the down-stream side. The dam is entirely of concrete, except for a top course or coping of granite and a granite nose or ice breaker at the free end. The structure was made unusually sturdy, since it will have to endure and serve its purpose without repair; once the construction cofferdam is removed the dam will never be seen again unless the "Falls" run dry or another cofferdam is built. Neither of these possibilities could be contemplated with fortitude by the engineers, so they decided to make their dam "a part of the geological formation of Niagara."

The construction of the masonry diverting booms is shown by Figs. 4, 5 and 6. Fig. 4 is a general elevation of the inner boom of which the



FALLS, ELECTRICAL DEVELOPMENT CO. OF ONTARIO.

drawings of Fig. 5 give the details. The structure is a buttressed wall pierced with arches: of the total height of 34 ft., the lower 24 ft. containing the arches is of concrete and the upper 10 ft. is cut stone masonry. As shown, this inner structure forms the foundation wall for the river side of the power house. The first or outer boom is of substantially similar design; the buttresses or counterforts as shown by Fig. 2 are considerably wider than those shown by Figs. 4 and 5. It will be noticed from Fig. 5 that mean water level is 5 ft. above the soffits of the arches at the crown. The final preventative of the entrance of ice or debris to the penstocks is the racks over the entrances; the construction of these is shown by Figs. 6 and 7, Fig. 6 showing the general arrangement and Fig. 7 the important special details.

The water gathered and freed from debris by the dam and masonry booms is, as shown by Fig. 2, conveyed downward through steel penstocks to water-wheels located in a deep wheel pit excavated in the ledge rock. There are eleven turbines to be provided for and the pit is 413 ft. long and 22 ft. wide in the clear. It is lined with a 2-ft. wall of brickwork, bonded to the rock walls with cement mortar and frequent anchor rods. The principal feature of interest of the design is the system of drains behind the lining. This is well illustrated by the drawings of Fig. 8. As will be seen, all water seeping through the rock is caught by the drains and conveyed to a sump whence it can be removed. Other points to be noted in the wheel pit construction are the solid rock foundations for the turbines, the concrete arch supports for the driving shaft guides and the concrete arch supports for the generators. The massiveness of the concrete arch work is especially noteworthy and may readily be seen from Figs. 2 and 8.

The waste water from the turbines is discharged alternately right and left into tail race tunnels. The location of these tunnels in reference to the wheel pit is shown in a general way by Fig. 2, and their dimensions are given in some detail in Fig. 9. Little need be said in addition to the illustrations except to call attention to the manner in which the discharge openings from the wheel pit into the tunnel are arranged.

The two branch tunnels join to form the main tail race tunnel at a point 165 ft. from the down-stream end of the wheel pit. From this point the tunnel is straight to the discharge and has a down grade of 5.5 ft. per 1,000 ft. A cross-section of the tunnel showing also the timbering used during construction is given in Fig. 10. The lining is brick, except the skew-backs, which are cut stone, and 300 ft. at the lower end where a concrete lining is used. The concrete lining was built in rings 6 ft. long, separated by planes of weakness, the idea being that, as the falls recede and the tunnel shortens, its length may be shortened by the dropping off of the lining in uniform sections, thereby preventing the cracking of the lining back of the portion shortened. Provision is also made for an observation gallery running the full length of the tunnel at the crown, so providing for frequent observations of the roof of the tunnels, and affording future possibilities for accurate observations of flow in large tunnel sections.

POWER PLANT.—The power plant, specifically the power house and machinery, will be given only brief mention at this time; the wheels and electric generators will receive special consideration in future articles. In general it may be said that unusual attention has been devoted to producing a power house design that presents a pleasing appearance. In how far this has been secured may be judged by the front-page picture and the following descriptive excerpt from the architect's report:

"After due consideration I decided to adopt a classic form of architecture, therefore I have designed the building in the style of Italian Renaissance, believing this style of architecture to be one of the most adaptable to answer the purpose designated. The elevation is about 40 ft. in height. The front elevation will have a center and two end bays and the spaces between center and end bays of the facades will be set back about 6 ft. with large windows and forming a loggia. In the front of this loggia will be formed a colonnade bringing out the upper portion of the building with a proper proportioned entablature, balustrading, etc. The main wall behind the colonnade will be carried up above the balustrading several feet to receive the roof, the floor of the loggia will be raised three steps. The intention is that the public may pass in through the colonnade and along the loggia to look down into the machinery room. The center bay will be enhanced by a portico which will be in keeping with the architectural lines of the colonnade with entablature, etc., and this bay will be further enhanced by being carried up several feet above the main roof. The end bays of the building will be similar to center bay, formed semi-circular and projecting and have colonnade around curve of same to give similar effect to the front colonnade and for the purpose that the public can look down through large window openings and have an end view of the interior of the building. The rear façade of the building next the river is to be finished plain. It is the intention to form around the building a wide terrace that will lift the building up above the roadway level several feet and to form ascending steps to same that will be continued around the several sides of the terrace enhanced here and there with parapets which will be finished off with handsome lamp posts. The top of the terrace leading from the steps to the building will be laid out with paved walks, sodded and formed with flower beds, so that when the building is finally completed it will have the appearance of being set up above the surrounding level, which will have a handsome appearance from the park. In connection with the building, might say that it is the intention generally speaking to build it of light granite, not to have any unnecessary elaboration but to emphasize its beauty by pure architectural lines and proportions so that when the building is completed it will have a characteristic appearance to answer the purpose for which it is intended, namely, a power house.

The machinery includes principally eleven turbines direct connected to alternating current gen-

FIG. 3. VIEW OF CONCRETE GATHERING DAM FROM LOWER SIDE.

erators. The turbines are of the vertical type, each of 13,000 HP., and were designed and built by the I. P. Morris Co., of Philadelphia, Pa. They will operate under a head of 143 ft. after deducting losses from friction and the velocity of approach and discharge. The connection between each turbine and its generator is made by a vertical hollow steel shaft approximately 115 ft. long, supported at three intermediate points by the concrete arch bearing supports previously mentioned. The current from the generators will be taken to a transformer station located in the ridge above the power plant and some distance away where it will be transformed and delivered to the line wires. These occupy a private right of way from Niagara to Toronto, on which is also being built the high speed electric railway previously mentioned.

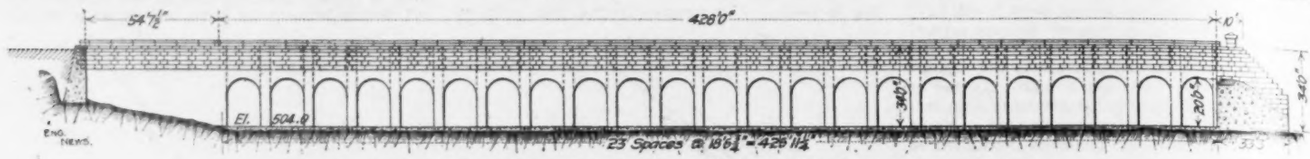


FIG. 4. ELEVATION OF INNER DIVERTING BOOM WITH SUBMERGED ARCHES.

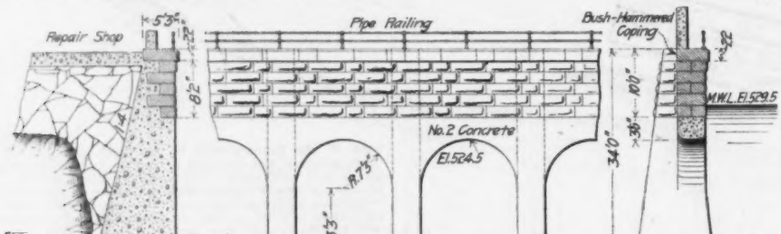


FIG. 5. DETAILS OF DIVERTING BOOM CONSTRUCTION.

GERMAN SPECIFICATIONS FOR DESIGNING, CONSTRUCTING AND TESTING CONCRETE STRUCTURES.

By Leon S. Moisseiff,* Assoc. Mem. Am. Soc. C. E.

The German Concrete Society had for some time a standing committee working on a complete set of specifications for concrete structures. The committee has reported the results of its labors to the last general meeting of the society in the form of a full set of specifications, which were adopted by the meeting. Steps have been taken by the society to procure the official adoption of these specifications by the building authorities and their embodiment in the building codes. The specifications are as follows:

I. General.

The specifications are intended for the construction of all kinds of concrete structures or such parts of structures as are built of concrete. (Note 9.)

Concrete is made of a concrete mass of a character designated by the term wet or of a mass of the consistency of moist earth designated by the term dry. It shall be capable of being tamped and only after more or less tamping shall it acquire the necessary density to develop the required resistance.

II. Planning and Designing.

For the preparation of plans and designs for concrete structures (drawings, statements, bids and awards) the following regulations shall be followed:

A.—DRAWINGS AND STATEMENTS.

The following information shall be submitted:

1. Drawings, showing the disposition of the structure as a whole and its details; see Section II, A6.

2. Statical computations giving the assumed loads and the proofs of the sufficient safety of the structures in a clear and easily verified form. A factor of safety of at least five shall be allowed. The tensile resistance of the concrete shall, as a rule, be neglected in the computations. (Note 2.)

3. A statement of the required compressive resistance of the concrete on cubes, after 28 days, which the contractor guarantees to produce. The compressive resistance of the concrete is of determining importance, the concrete shall, therefor, be judged by its compressive resistance. (Note 3.)

4. Statements as to the proportions of the concrete which shall develop the required or guaranteed resistances; also data on the derivation, character and consistency of the materials to be used, such as, for instance, the proportions of sand and gravel in their natural state. (Note 4.)

5. Statement as to the manner of preparing the concrete, wet or of the consistency of moist earth; the method of mixing, by hand or machine, and the greatest depth of the concrete layers.

6. Occasional special explanations, for example, on the process of construction, difficult structural parts, disposition of hinges and joints for taking up motion and the like.

In the designing of concrete structures special consideration shall be given to the behavior of concrete under changes of temperature and moisture. Information as to the arrangement of hinges and joints for movement, if any, shall, therefore, be contained in the submitted statements on the process of construction.

B.—PRELIMINARY CERTIFICATION OF RESISTANCES.

The contractor, if the free choice of the building materials be left to him (Note 4), or in the case of special bids, is bound, at the request of the owner or the building authorities, to supplement his statements with proofs that the proposed proportions of the proposed materials and the proposed method of preparation will produce the desired or guaranteed compressive resistances. (Note 5.)

The submitted construction plans must be signed by the designer and also by the contractor immediately in charge of the work not later than before the beginning of the work. The permission of the building authorities to erect the structure in no way frees the author of the plans and the contractor of the full responsibility for the plans and construction of the structure.

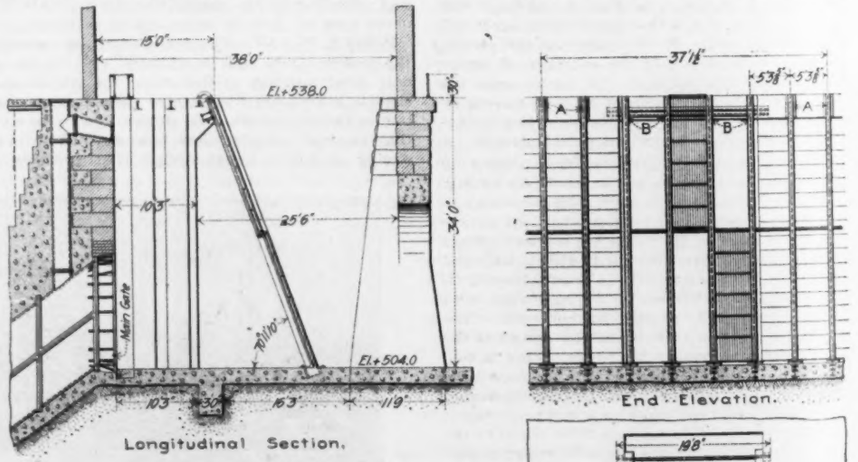


FIG. 6. GENERAL ARRANGEMENT OF RACKS OVER PENSTOCK MOUTHS.

III. Construction.

A.—GENERAL.

The contractor is bound to adhere to the statements made by him in his bid, except in special cases. (Note 6.) If the contractor cannot prove the guaranteed resistance or maintain it during construction he shall, in case there be no other agreement, at his own expense, so change the materials, proportions, mixing and making of the concrete that the required resistance shall be attained, and he shall, further, furnish the proofs of the successful results. (Note 7.)

Concrete may be laid in freezing weather if the injurious effects of freezing be prevented by proper means. Frozen materials shall not be used.

B.—SUPERINTENDENCE AND WORKMEN.

The contractor of concrete structures shall put in charge of such work such persons only as have thorough knowledge of this kind of construction. All work shall be done under the superintendence of trained and reliable foreman. At the request of the owner or building authorities the contractor is bound to furnish such evidence as will show that the persons in charge of the superintendence and direction of the work have already previously been successfully employed on the construction of concrete structures. (Note 8).

C.—BUILDING MATERIALS AND THEIR WORKING.

(a) *Materials*; Cement.—Cements which fulfill the requirements of the standard specifications for Portland cement shall be used exclusively. (Note 9.) Quick setting cement shall not be used for concrete, except in special cases. (Note 10.)

Sand, Gravel and Broken Stone.—In these specifications is meant under "sand;" all kinds of sand, land, river, or sea sands, as well as broken or crushed products, from fine grains to 0.28-in. diameter, (Note 11); under "gravel;" all kinds of gravel from 0.28-in. grains up; under "gravel-sand," the natural mixture of sand and gravel as it is found in excavations and in beds of streams.

The sand, gravel and broken stone shall be suitable for the making of concrete (Note 12), and shall not contain vegetable matter or other impurities (Note 13). As a material for sand and gravel any kind of hard rock is suitable. To obtain a dense concrete the sand and gravel shall be of various sizes, that is, they shall contain various shapes and sizes of grains in corresponding proportions. According to the thickness of the concrete body gravel up to 2 ins. in diameter may be used (Note 14). For broken stone only hard rocks, unaffected by the weather, shall be used. As a rule, the broken stone shall also be of different sizes of stones as the concrete

*Park Row Bldg., New York City.

mass can then be worked easier and better and gives a denser and stronger concrete. The sizes of the stones vary with the thickness of the concrete mass. The largest stones shall, according to their use, pass in any direction through a round hole of 2,4 to 2.8 ins. diameter or a square of 2 to 2.4 ins. on a side. Particles of sizes smaller than 0.28 in. down to stone dust shall be considered as sand (Notes 13 and 14).

Water.—The water used shall be clean and free of any admixtures which interfere with the hardening of the concrete. Marshy water is injurious.

(b) *Preparing the Concrete*; Proportioning the Materials: (Note 15).—The proportioning of the materials shall be done so that it shall be possible at any time to determine the quantities of the individual constituents. If the cement be measured by volume it is understood that it is emptied into the measuring vessel without dropping and the latter is not shaken. To convert volumes into weights a cubic foot of Portland cement shall be taken as 87.5 lbs. In using measuring vessels the filling shall always be done in the same manner, so that the materials shall always have the same density when being measured. Gravel-sand and mixed broken stone may in many cases be used without being separated. Tests shall then be made by sieving to determine the proportions of the sand in the gravel or the stone dust in the broken stone. Sometimes the desired proportion may be obtained by the addition of the proper quantity of sand, gravel or broken stone. In making concrete to be used for structures with high intensities of stress or in the case of a very variable gravel-sand, it will have to be decided in each given case whether the sand and gravel shall be separated (Note 16).

Mixing by Hand.—When mixing by hand the materials shall be mixed in a well laid, strong and tight-jointed mixing box or on any even, strong and not absorbing platform. The sand or gravel-sand shall first be mixed dry with the cement to a mixture of uniform color, then only shall the previously wetted gravel or stone be added and the whole, together with the water added to it, shall be mixed further until a uniformly wet mass is produced.

Mixing by Machine.—Concrete mixed by machine is, everything being equal, always superior to one mixed by hand. The time required for mixing with different kinds of machines is not only depended on the type of the machine but also of the character and quantity of the materials mixed. When mixing by machine the mixture is mixed first dry one-half of a minute to a minute, according to the machine, and the mixing is then continued with a gradual addition of water until a thoroughly mixed, uniformly wet mass is produced. The time of mixing may be regarded as sufficient, in hand, as well as machine, mixing, when the stones are coated on all sides with thoroughly mixed mortar.

Addition of Water.—The proper time to add the water during the mixing of the concrete varies with hand and machine mixing and it is also dependent of the ingredients and the working methods of the contractor. According to the quantity of water added concrete is classified as wet or as of the consistency of moist earth or dry earth. The quantity of water to be added depends on the character of the materials, the mixing proportions, the atmospheric conditions, the degree of moisture contained in the materials and their absorptive capacity (Note 17). When making concrete of the consistency of moist earth enough water only shall be added that the concrete can just be squeezed into a ball by the closing of the hand, leaving moisture on the skin. When making wet concrete the proportion of water shall be so far increased as to make the concrete wet during the tamping.

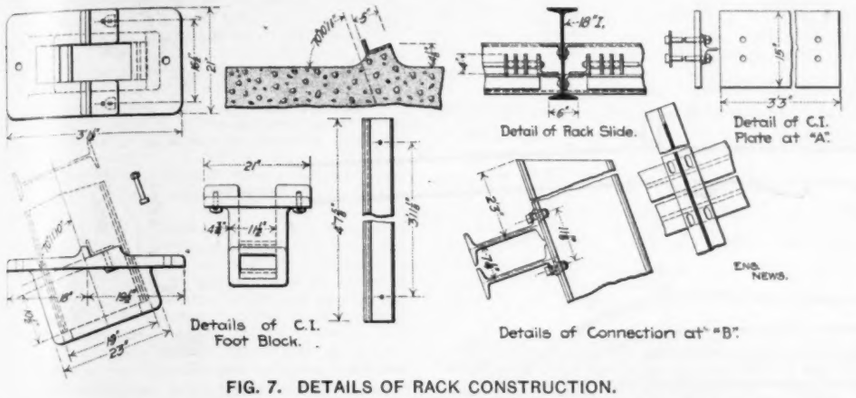


FIG. 7. DETAILS OF RACK CONSTRUCTION.

(c) *The Laying of the Concrete*; The same as in the mixing of the concrete sufficient freedom of choice must also be left to the expert judgment of the building authorities and the contractor in the laying of the concrete.

Concrete Layers—The concrete shall be laid in place (excavation or forms) in layers only and in such depths that the thickness of the completed layers after tamping shall not, as a rule, exceed the following amounts: For concrete of the consistency of moist earth, according to the stress, 6 to 8 ins.; for wet concrete, according to the stress, 8 to 12 ins. Within these limits the lesser thickness gives the greater resistance. Special attention shall be given that any larger stones which may have separated from the mass be again mixed with mortar.

The individual layers shall be laid, wherever possible, at right angles to the direction of pressure in the structure, and wherever this be impossible the layers shall be laid parallel with the direction of pressure (Note 18). The layers shall, as a rule, be laid on fresh concrete to obtain a sufficiently strong adhesion between the layers. If the surface of a freshly tamped concrete of the consistency of moist earth should become smooth due to the tamping or some special properties of the materials, as f. i., five grains of sand or a rich percentage in the latter of clay or fine dust, this smoothness shall be removed immediately after the tamping. In all cases the surface shall be roughened by sweeping with steel brooms.

If freshly laid concrete layers are laid on layers already set provision shall be made for a sufficiently strong connection between the layers. In addition to a suitable arrangement of the concrete structure itself, it is recommended to sweep the joining surfaces vigorously with wet, steel brooms immediately before the laying of the fresh concrete and to cover them with a thin cement grout. For laying concrete rich in stone it is recommended, besides, to spread a thin layer of wet mortar of at least the same proportions as the mortar used in the concrete.

Tampers.—Square or rectangular tampers 4 to 6½ ins. on a side and 22 to 27 lbs. weight shall be used.

Manner of Tamping.—The amount of tamping to be done depends on the resistance to be obtained and the character of the concrete (wet or dry) (Note 19). Special care shall be given to tamping the edges and external surfaces alongside the molding planks. The individual tamping areas shall overlap each other. With a dry concrete rich in stone it is recommended to sweep the surface between the tamping periods and to distribute the detached mortar into the depressions.

Duration of Laying Concrete in Place.—The laying of the concrete shall, as a rule, begin immediately after its mixing and be carried on rapidly enough to be completed before setting. The mixed concrete shall not be left unused, even in special cases, longer than one hour in warm and dry weather and not longer than two hours in cool and wet weather. Such concrete which will not be used immediately shall be protected against the influence of the weather, as the sun, wind, heavy rain, etc., and shall, besides, be reshoveled before being laid in place. Concrete already laid in place shall, in all cases be worked immediately and without interruption until the tamping has been completed.

As to laying concrete in freezing weather see Section III. A.

D.—FORMS AND SUPPORTS.

The forms or molding planks shall be of such thicknesses and so firmly connected and supported as to insure the exact shape of the concrete body to be made in them. They must allow the laying and tamping of the concrete in layers and be removable, easily and without danger, leaving in place such supports as may be necessary. The time which shall pass between the completion of the tamping and the removal of the forms and supports depends on the character and size of the concrete body and also on the weather. If freezing weather occurs during the hardening period the time for the removal of the forms shall be extended at least by the duration of the freezing weather.

E.—TREATMENT AND PROTECTION OF CONCRETE UNTIL SUFFICIENTLY HARDENED.

Concrete members shall, after the completion of the tamping, be protected in a suitable manner against injuries as well as against influences which might exert an injurious effect on the acquiring of its required resistance. Not to deprive the concrete prematurely of the water required for the hardening, sunshine and wind shall be kept away during the first days as much as possible, leaving the concrete in the forms, covering it with a layer of sand, bags, boards, etc. Periodical wetting is necessary (Note 20).

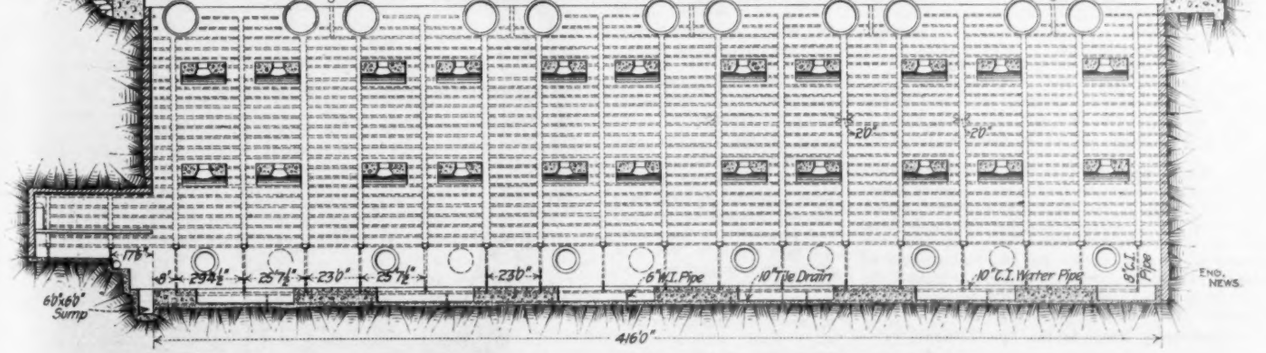


FIG 8. VERTICAL SECTION OF WHEEL-PIT SHOWING WALL DRAINAGE SYSTEM.

IV. Inspection and Testing of Structure.

A.—INSPECTION AND TESTING DURING CONSTRUCTION.

The inspection and testing shall, as a rule, comprise the following items:

(1) The proper construction of the forms and supports

and the correctness of their dimensions relative to the structure; see Section III. D.

(2) The correct preparation, mixing and making of the concrete; see Section III. C 2 a.

(3) The correct laying and tamping; see Section III. C 2 b.

work and operating plant do not furnish a sufficient guarantee for the good quality of their work, and who do not dispose of sufficiently trained men, require special attention by the building authorities during the inspection and testing of the construction.

(1) The specifications and the explanations to them may erally required. Frequently the time available between the bid and the award of the contract will be too short for this. Under such conditions compression tests on 14 days old cubes will furnish conclusions as to the resistance to be expected after 28 days; but the making of 28 days old tests for conclusive proof must be em-

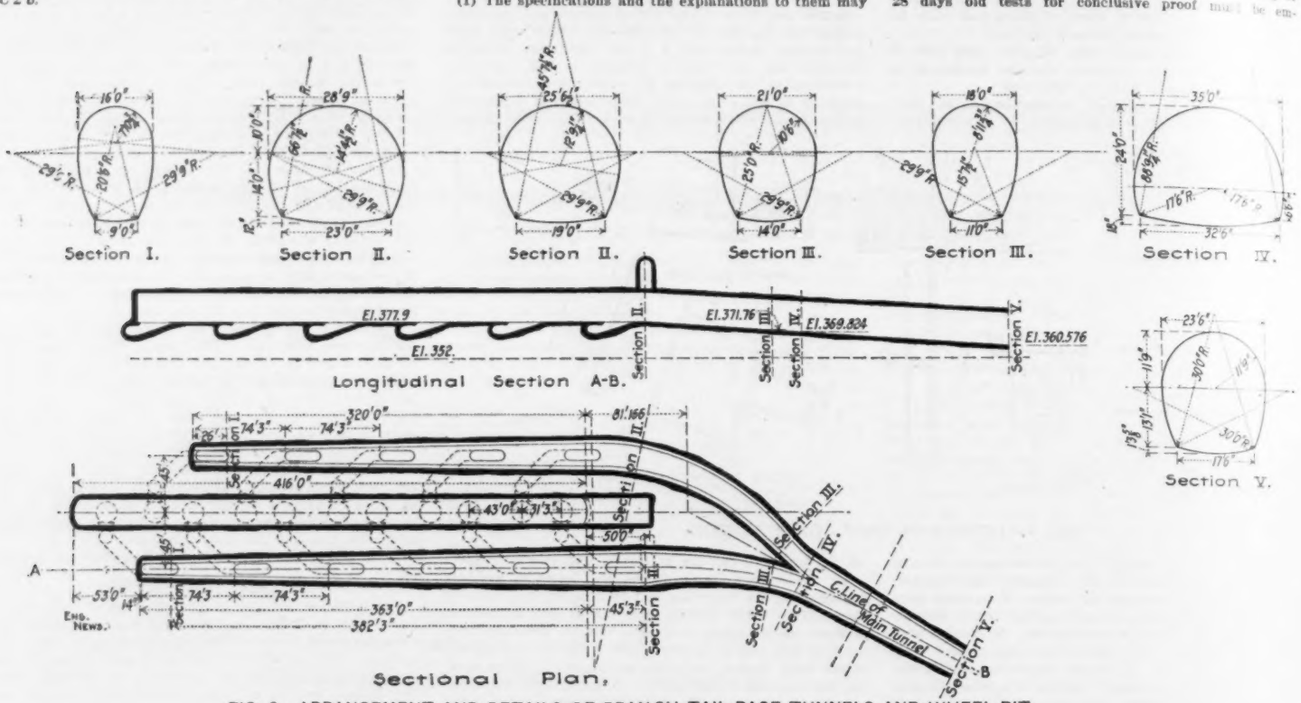


FIG. 9. ARRANGEMENT AND DETAILS OF BRANCH TAIL-RACE TUNNELS AND WHEEL-PIT.

(4) The proof that the concrete laid will develop the required or guaranteed resistance; see Section II. A 3. This can be obtained by compression tests on test specimens which shall be prepared under supervision (Note 21).

B.—TESTING AFTER THE COMPLETION OF THE STRUCTURE.

The testing of the completed structure shall, as a rule, comprise the following:

(1) The proofs of sufficient hardening of the structural parts before the removal of their forms.

(2) The determination of the soundness of all parts after the removal of their forms.

(3) The determination that all the required thicknesses and dimensions have been complied with.

(4) Sometimes the determination of the sustaining power of the structure by load tests. The character and extent of such load tests shall be in accordance with the usual tests of this kind for structures. Such tests shall always be made when there is a well founded suspicion that some parts of the structure have been constructed in a manner not free from objections or that their sustaining power has been injured, due to some influences. The load tests shall not be made before the sufficient hardening of the concrete may be presupposed.

C.—DUTIES OF THE CONTRACTOR.

The contractor is bound and shall be ready at the request of the owner or the building authorities to furnish the proofs for the good quality of his work by the tests specified in the above under Sections IV. A 4 and IV. B 4.

If the question who shall bear the costs of these tests be not settled by the established laws or special agreement, the expenses of the tests specified under Section IV. A 4 shall so be divided that the contractor shall supply the materials, the forms, and make the test specimens at his own expense and all other expenses of testing be paid by the owner. The costs of making the tests under Section IV. B 4 must be met by the owner if their results prove to be generally satisfactory.

Explanatory Notes to the Specifications.

The specifications and these explanatory notes are the result of the collected experience in concrete construction as it is known to date. Wherever directions were treated of which apply in all cases and should be observed they are given in peremptory form, where, however, according to the character of the subject, a certain amount of choice is to be left to the judgment of the building authorities, inspectors and contractors, the directions are worded in an advisory form.

The best guarantee for the proper construction of concrete structures is furnished by placing the construction in the hands of experienced and well reputed experts. Contractors who by their technical education, previous

also be applied, to a certain extent, to structures of concrete wet enough to be cast into molds.

(2) The meaning of a factor of safety of five can be determined in each individual case only. For direct compression this means that the greatest allowable compressive stress shall not exceed one-fifth of the compressive resistance of the concrete as found on cubes 28 days old.

(3) The resistance of the concrete is materially influenced, except by the proportions of the ingredients, by the qualities of the materials, the quantity of water, the manner of mixing and making of the concrete, the treatment of the freshly tamped concrete and the conditions it hardens in and, finally, the rigidity of the falsework and forms, the reliability of the workmen and the supervision exerted. The quality of a concrete cannot be judged, as usual heretofore, by the mixing proportions alone; the concrete must, on the contrary, be evaluated by its compressive resistance primarily.

(4) If not specially prescribed by the owner's specification or building regulations, the contract shall have the full freedom of selecting and proportioning the materials with which he intends to attain the least resistance required by the structure, specified to him, or guaranteed by him. He must, however, state what materials and proportions and what methods of mixing and making he intends to use to produce the required resistance to enable the inspector to test the same.

(5) It may sometimes suffice as a temporary proof to produce certificates of tests of previous compression tests on cubes which were made in the same manner and with materials of the same qualities as proposed. To prove the resistance of the proposed concrete by compression tests on 28 days old cubes at least 5 to 6 weeks are gen-

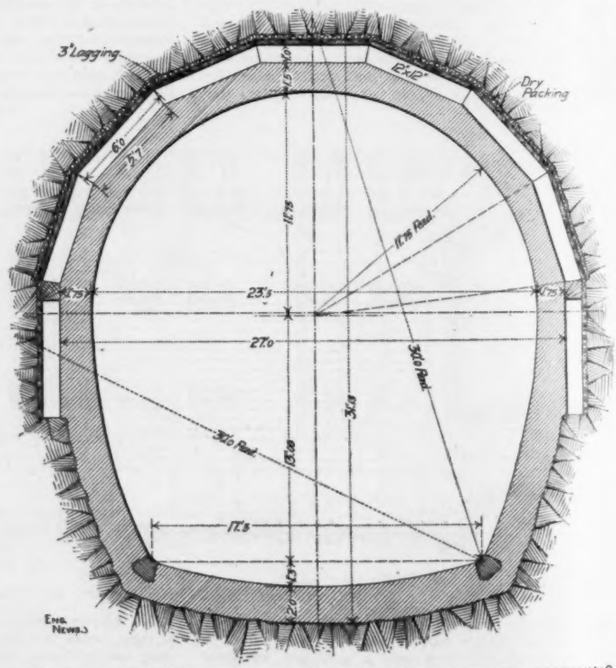


FIG. 10. CROSS-SECTION OF MAIN TAIL-RACE TUNNEL SHOWING LINING AND TIMBERING.

phasized. It should be taken into consideration that resistance of the cubes is generally not fully attained in the structure.

(6) Peculiarities of the building ground, sudden changes of weather and the like sometimes require modifications of the proposed method of construction to produce the required resistance. The consent of the owner shall, however, be required for such changes.

(7) Whether and under what conditions poor concrete already laid shall be left in place has to be especially agreed to between the parties.

(8) Training and expert knowledge of the superintendent and workmen must complement what cannot be laid down in fixed rules. Thus, f. i., the quantity of

water to be added to the concrete during mixing cannot be prescribed beforehand as it depends materially on the weather and the variable degree of moisture of the materials. Concrete is a product in the maxing of which allowance must be made for the sudden appearance of the most varied conditions. The finished concrete will therefore be of greater uniformity and better quality the more experienced, able and reliable the men who make it.

(9) These specifications can be applied to their full extent and without further comment to Portland cement concrete because only for such a concrete there are enough experience and investigations on hand to establish generally valid rules for its making and laying. In how far these rules would apply for other cements also requires special determination for each individual case.

(10) The setting of the concrete is affected by the temperature and moisture of the air and the temperature of the water used. High temperature accelerates setting, low temperature retards it. In the presence of water pressure the use of quick setting cement is frequently necessary.

(11) Sand made of granulated furnace slag of proper consistency shall be considered equivalent to mineral sand.

(12) No exhaustive general rule can be laid down as to the character of the materials for the concrete. The main weight shall be laid on obtaining a concrete of high or at least sufficient resistance with the materials used. Loam, clay and similar admixtures have an injurious effect on the resistance of the concrete if they adhere to the sand and stone. If they are finely distributed in the sand, without adhering to the grains, they are, as a rule, harmless and may even sometimes increase the resistance. In the former case the materials can sometimes be made good for concrete by washing, in the latter washing would frequently be a mistake. In cases of doubt as to the advantages or disadvantages of such admixtures compression tests on concrete cubes shall decide.

(13) The stone or gravel used shall, as a rule, have at least the same resistance as the hardened mortar of the concrete. Stone not weather-resisting, soft sandstone, underburnt brick shall not be used for concrete. From previous experience it appears necessary to test slags, like boiler slag, locomotive and broken furnace slag, as to their suitability for concrete. Such materials have given in some cases good results and in others bad ones. Coal particles which are found in various river sands may also have injurious effects.

(14) Clean stones of larger size of good compressive resistances and weathering qualities may be embedded in the concrete up to 40% of the total volume if the character and dimensions of the member allow it and provision be made for a proper distribution of such stones in the concrete as well as for the use of a sufficiently wet concrete to surround them completely with it.

(15) In making the concrete the same results may frequently be obtained by different manipulation. Rules of general applicability cannot be well established, the more so as the conditions may differ in each case and as, further, the choice of the process to be pursued, besides depending on the character and object of the structure to be built is also affected by the character of the materials, proportions, method of mixing (hand or machine), consistency of the concrete (dry or wet), degree of temperature, degree of moisture in the air, experience and working habits of the contractor.

(16) The use of gravel-sand in the unseparated state is more economical, and, in most cases, permissible. The complete separation of the sand and gravel and the mixing of the concrete in the due proportions guarantees, however, the full uniformity of the mixture and facilitates the testing. But as this procedure is costly, it must when required, be definitely specified in the specifications at the time of the letting of the contract.

(17) More water is required in dry and hot weather than in cool and wet weather. When laying concrete in wet excavations the quantity of water will have to be reduced when on a porous absorbing ground the quantity of water will be increased and the ground must be wetted before laying the concrete.

(18) Tamping in the direction of the pressure insures a uniform deformation of the concrete in the whole section and is to be desired primarily. Where this is impracticable or where the quality of the tamping in the desired direction would suffer, as, f. i., in a flat arch, care shall be taken that the tamping shall not tend to displace the individual layers.

(19) Dry concrete requires more effort in tamping and greater care by the workmen and superintendent than wet concrete; but it generally produces for the same amount of cement a higher resistance than the wet concrete. With dry concrete the limit of tamping is reached when the mass does not compress any further, or it becomes elastic, or it disengages water. Water cannot always be made to disengage because the special qualities of the materials also exert their influence. Wet concrete when tamped too long may cause separation of the ingredients and thus be injurious.

(20) Wetting of unprotected fresh concrete which had been much heated by the sun is injurious.

(21) It should be remembered that the resistance on cubical specimens is generally not fully attained in the structure, as has already been mentioned under Note 5. The continued making and testing of test specimens furnishes also a tried method for testing the correct proportions and time of mixing. The contractor himself can also know his own work by continuous tests only (Note 5). When making the test specimens care shall be taken to observe as much as possible the same manner of execution as on the building ground.

It is recommended for the progress of concrete construction to make, when building large structures, several series of tests and to publish the results. The number of test specimens is determined by the number of different kinds of concrete and the number of test pe.iods.

MAGNETIC SWITCH CONTROLLERS ON ELECTRICALLY-OPERATED AUTOMATIC ORE UNLOADERS AT LORAIN, O.

By R. I. Wright,* Assoc. Am. Inst. E. E.

An article in Engineering News of Aug. 3, 1905, showed and described an installation of a new type of unloading machine, the Hulett Bucket-leg Ore Unloader, built by the Wellman-Seaver-Morgan Co., of Cleveland, O., for the ore receiving docks of the National Tube Co. at Lorain, O.

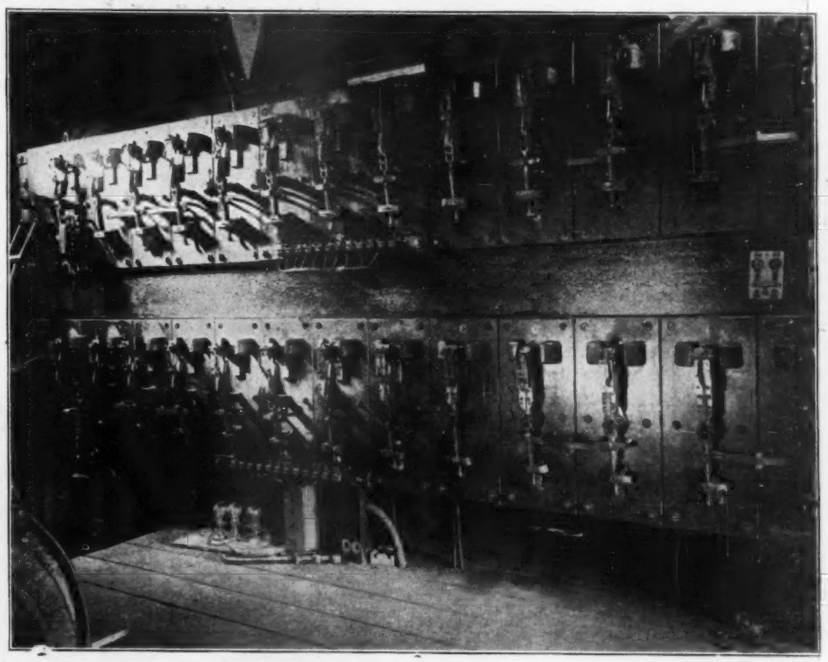


FIG. 1. MAGNETIC SWITCH PANEL BOARD FOR BUCKET-LEG HOIST AND CARRIAGE TRAVEL, HULETT AUTOMATIC ORE UNLOADERS, LORAIN, O.

These ponderous machines, whose primary object is to enable rapid and cheap unloading of large ore steamers, are operated in all their motions by electric motors, and depend for efficient action in no small measure upon the controlling apparatus by which the motors are directed. The following gives a brief description of the control equipment, with photographic views of some typical elements of the equipment.

An unloader of the Hulett type has the following motions: (1) Carriage travel, back and forth on the gantry bridge; (2) Carriage tilting, that is, bucket-leg hoist; (3) Bucket rotation (about a vertical axis); (4) Bucket closing and opening; (5) Travel of the auxiliary hopper-car at the rear of the machine, which takes ore from a hopper into which it is dumped by the unloading bucket, and elevates it to the stock pile; (6) Traverse of the entire machine on tracks parallel to the dock, and slewing the machine by differential motion of the two trucks. Each of these motions is performed by one motor. The motors are series and compound wound and operate on a 220-volt direct current circuit.

The controlling equipment is of the remote-control type. The controllers proper consist of a number of electrically-operated clapper switches, which cut resistance in and out of the motor circuits, and are themselves controlled by small drum controllers carrying low currents. The switches are operated by solenoids placed on the back of the switch-panel. The main contact of each switch is a heavy laminated copper brush reinforced with a yellow brass contact; the final break, when the switch is opened, is taken between carbon contacts and the arc is quickly ruptured by a powerful magnetic blow-out. The small master switches, which actuate the main switches, are located in the operators' cabs. As the solenoids of the main switches require a current of only a few amperes, the wires connecting the master switches with the controllers proper are of very small size. The main controllers are located near to their respective motors, so that the heavy wires carrying large currents are made as short as possible. The master switches or operators' controllers are small, thus allowing an arrangement by which all operating handles are brought within easy reach of the operator. Their manipulation requires very little effort on the part of the operator, thus allowing full output of the machines at all times irrespective of the physical condition of the operator.

Each motion of the unloaders is provided with a positively connected-or geared automatic cut-out or emergency-switch. The cut-outs on the Unloader-leg Hoist and Car Travel automatically slow down and stop these motions as the limits of travel are reached. They operate to first gradually introduce resistance in the motor armature circuit, to slow down the motor; then change connections to convert the motor into a generator, thereby applying a gradual dynamic braking effect until the motion is nearly stopped; and finally apply band brakes set by an electromagnet. The application of dynamic braking to the above-mentioned motions is of particular advantage on account of the great weight of the moving parts, as the energy of these heavy parts is absorbed and dissipated in the resistance, thus removing practically all wear from the band brakes. Under these conditions, the band brakes operate merely as holding brakes and are called upon to stop the motion only in case of failure of current supply. The Bucket Rotation and Trolley motions are supplied with geared automatic slow-down and cut-out devices which insert successively increasing resistance in the motor circuit and finally apply solenoid band brakes to stop the motion as

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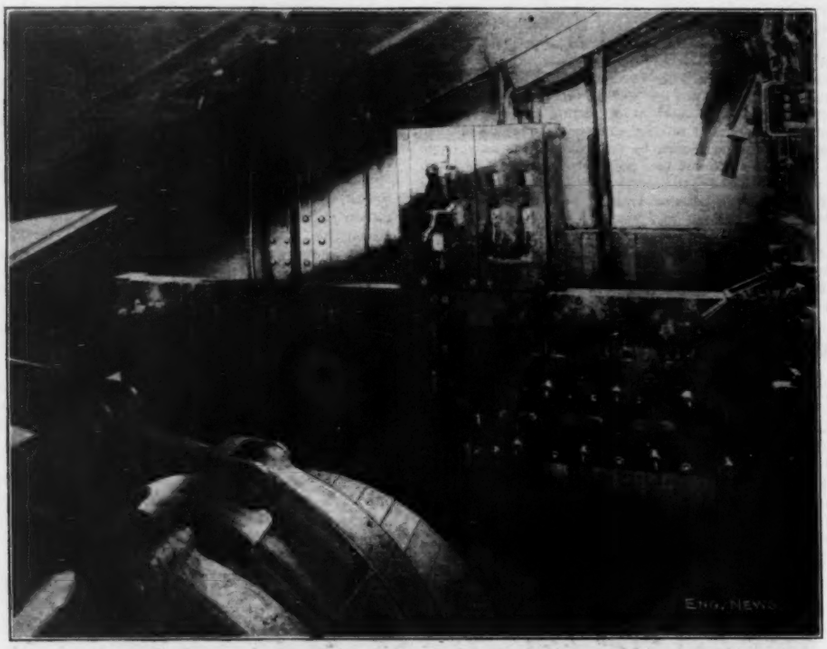


FIG. 2. MAGNETIC SWITCHES FOR BUCKET-CLOSING MOTOR.

the limits of travel are approached. As these motions involve relatively light parts, dynamic braking is not provided in the automatic stop.

While all of these automatic devices fully protect the machinery and motors in case of failure of current supply, and against the results of confusion and faults of the operators, still they allow each of the two operators full control of the motors at all times, except that he is unable to pass a predetermined limit of travel of the motions.

The main controllers of the Bucket-leg Hoist and Carriage travel are shown in the view Fig. 1 herewith. At the extreme right of the board are seen four pairs of switches, the two switches of each pair being interconnected by means of horizontal levers; these are the reversing switches and the function of the levers is to absolutely prevent the closing of the switches for opposite directions at the same time. At the left end of the board are three switches similarly interconnected by two levers; the function of these levers is (1) to prevent the closure of the middle or dynamic-braking switch while the motor is still connected to the line and operating as a motor, and (2) to hold open the line switches (at either side of the center switch) while the motor is acting as a generator with the center switch closed. The intermediate magnet-switches control the connection of the resistances used in starting and in the automatic cut-out. Fig. 5 gives a view of one of the magnetic switch units of the controller.

The bucket-closing motion, the motor for which is located on the rear end of the walking beam, is controlled by the switches shown in Fig. 2. The principal feature of this motion is the provision for automatic acceleration. Each switch magnet is so connected (electrically) to the magnet windings of the preceding switch that the current taken by the motor must fall to a predetermined value, after the closing of the preceding switch, before the switch can close. This means that the motor must reach a speed corresponding to a given switch before the next resistance switch can close. The smoothest possible acceleration, in the shortest time consistent with safety of motor and drive, is secured by this arrangement. Rapid throwing of the master switch cannot adversely affect the motor. The effect on the bucket mechanism is to make the motor drive almost precisely equivalent to steam or hydraulic drive; the motor will close the bucket at such a rate that a predetermined pressure on the bucket jaws is not exceeded. As a matter of fact, the motor is stalled on the average once during every closure of the bucket, and this occurs without injury to motor, controller, or operating mechanism. The automatic acceleration switches are at the right in the view Fig. 2. In the foreground is the electromagnetic band brake for holding the bucket in any given position.

The bucket rotation is controlled in only two steps, and, as it takes but a small current, a smaller and simpler form of magnetic switch unit is used for this motion.

The operation of the auxiliary hopper car is controlled by a switchboard similar to that shown in Fig. 1, but of fewer steps and therefore of more compact arrangement. The motor for this motion, and the panel board carrying the magnet switches, are located in the machinery house under the main carriage. The dumping of the car at the rear end of its travel is done by mechanical dogs.

The type of master controller used in this equipment is exemplified by the bucket-carriage master

FIG. 3. MASTER CONTROLLER FOR BUCKET-LEG HOIST AND CARRIAGE TRAVEL.

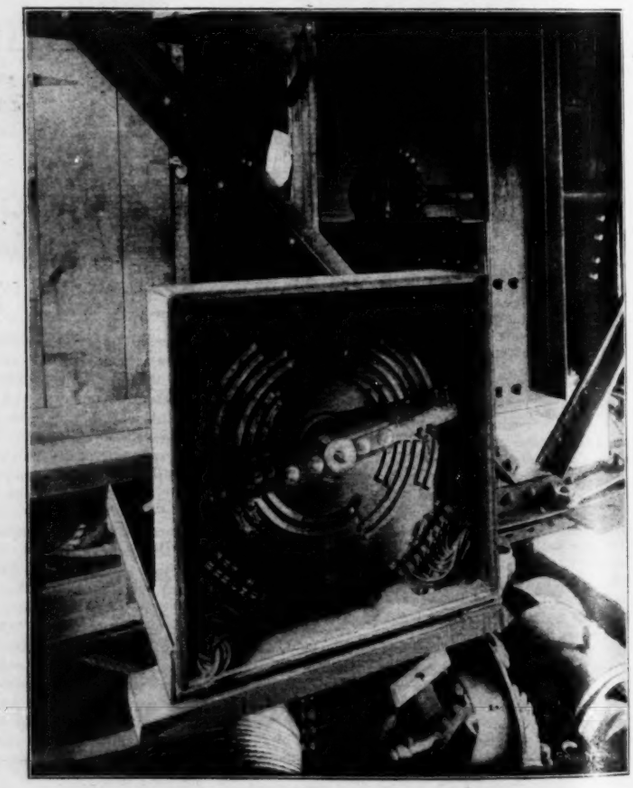


FIG. 4. GEARED MASTER CONTROLLER FOR AUTOMATIC LIMIT-STOP OF CARRIAGE TRAVEL.

controller, shown in Fig. 3. The manually operated controller seen at the left in this view controls a motor for slewing the entire machine, to bring it parallel to the hatches of the vessel. The dock is built on a large curve, which makes the motion necessary for best operation

The mechanically geared automatic slow-down and cut-out for the main bucket carriage motion

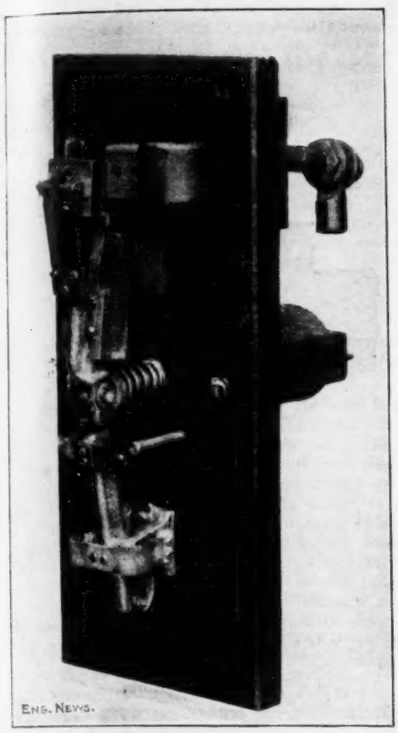


Fig. 5. Remote-Controlled Unit-Switch of Main Controller.

is shown in Fig. 4. This actuates appropriate magnet switches on the board shown in Fig. 1.

The control equipment described was designed, built and installed by the Electric Controller & Supply Co., of Cleveland, O., who also manufactured and supplied the cushion-type solenoids for the band brakes, and all other electrical details.

THE MANUFACTURE OF CONCRETE BLOCKS AND THEIR USE IN BUILDING CONSTRUCTION.

(Extracts from Papers Submitted in Engineering News Competition, and Not Receiving Prizes.)

III.

Besides the two papers awarded prizes in Engineering News Competition, there were received ten others, nearly all of which contained contributions of value to the knowledge of the subject of concrete block manufacture and use. From these ten papers we have selected extracts, and arranged them under descriptive headings for publication. The method of presentation adopted as most nearly fair to all is to give the author's name in each case, and follow it with the extract selected in as nearly as possible the author's own words. When two or more authors have presented the same fact, that author's presentation which seemed to us best, judged by the rules under which the competition was held, has been chosen.

The names and addresses of the authors from whose papers extracts have been taken are as follows: Joseph Babiczky, Guardian Trust Building, Kansas City, Mo.; Geo. H. Crafts, Box 245, Atlanta, Ga.; H. H. Frantz, 3621 West Grand Ave., Des Moines, Ia.; U. G. Hayne, Fort Stevens, Ore.; Noyes F. Palmer, 150 Snediker Ave., Brooklyn, N. Y.; H. H. Rice, 381 South Logan Ave., Denver, Colo.; H. G. Richey, Superintendent, U. S. Public Buildings, Evanston, Wyo.; G. W. Robertson, 105 Walnut St., Marion, O., and G. W. Stevens, 15 Warrenton St., Boston, Mass.

The subjects considered in this article and the remarks under each are as follows:

Curing Molded Blocks.

Geo. H. Crafts.—After molding the next process in the proper making of blocks is the curing. This process is one of the most important in the manufacture of first class blocks, although, as a usual thing, no attention at all is paid to it. Most block makers consider that the block is made as soon as it comes out of the mold, and they put it out in the sun or in any old place where it is handiest and pay no attention whatever to the curing of it. Any concrete material to attain its greatest strength and have the best appearance must be properly used, and this curing consists in keeping the material in the shade and in a wet condition for a number of days after it is made. If concrete dries out immediately after making, the action of the cement is deadened and the concrete is crumbly and weaker than if kept wet until the cement has had full time to harden. All good authorities recognize this fact and proper means for the curing of all blocks should be a part of every building block plant. The blocks should be kept in the shade and thoroughly wetted for a week or ten days in order to receive the proper curing.

U. G. Hayne.—After the block is safely set it should be gently sprayed with water, care being taken not to have the spray of such force as to disintegrate the face of the block or mar the corners. After ten or twelve hours there is little danger of the block receiving too much water. The intelligent care used in curing molded concrete work has almost as much to do with attaining its ultimate strength as the quantity of cement used. The early drying of the block will have a tendency to dry out the corners before the initial set is fully completed, leaving them with little strength and likely to crumble at a touch. Plenty of water for about ten days is what the work needs after the first sprinkling is given.

Joseph Babiczky.—Curing of the blocks is one of the most important processes of their manufacture, and must be watched very carefully. In summer the heat and in winter the frost is very injurious. In summer after the blocks have set so far that sprinkling does not hurt them they must be sprinkled over and over again. A boy with a watering pot which is equipped with a rose spray and which sprays the water in a uniform stream is one of the best devices for small and medium size plants. If there is city water under pressure it serves well, but I would suggest in the first 48 hours the exclusive use of the watering pot, as the pressure of the city water can easily injure blocks in the early stages of hardening. Apply water in abundance.

H. G. Richey.—Concrete blocks should always be cured by wetting or sprinkling them with water. Blocks which have sharp corners or arrises or any sharp projections should be given special care to keep these projections moist and prevent their drying too rapidly. A number of block manufacturers have failed to produce ornamental blocks with sharp and distinct lines, the principal reasons being that the mixture used was so poor and the projections or ornamentations of the blocks were allowed to dry too rapidly. Blocks as soon as taken from the molds should be placed in the curing room or shed, which should be built so as to exclude all sunshine or draughts of air. As soon as hard enough, which will be in about ten hours, the blocks should be sprinkled lightly with water and covered with a wet cloth or burlap; they should then be wet four times daily for about seven days, and should not be removed for use until they have attained an age of about 15 days.

Facing and Coloring.

H. H. Rice.—I now challenge your attention to that much mooted question of body and facing, as well as various forms of face and colored blocks. Eliminating face matter from your process of manufacture, you are compelled to make your entire block of such material as will produce the face you desire. That is to say, if you wish a rich face your entire block must be unnecessarily rich in cement. If you wish a fine face your entire aggregate must be of fine sand, and result either in a loss of strength or in the use of an inordinate proportion of cement. A standard argument against facing is that it does not increase strength; certainly not. Though face matter contains a much greater percentage of cement than does the body of the block, yet the aggregate of the face is very fine sand and hence possesses no greater strength than that obtaining in the body of the block through the use of a smaller percentage of cement with coarser material in the aggregate. Now, do you wish to use a similar composition throughout the block, with consequent loss of strength unless the amount of cement be abnormally increased? Certainly not. What then? Do you desire the face of your block to be of coarse material? Certainly not in a quality of blocks to compete with pressed brick and cut stone. The opposition to facing has largely arisen from the old style of mold in which faces are formed by the upright sides, and in which there is no device for facing otherwise than by the use of a partition. A popular demand always brings forth some remedy for any existing evil, and this fault is now overcome in various ways in various machines. Some now make the face on the bottom of the mold, some tilt the mold at an angle in order to put in the face matter first, some make the two-piece blocks with face up, putting the face matter in last and then applying pressure from the top. Of these various machines more in their order, but the fact I wish here to establish is that the various devices now in use for facing prove beyond a doubt that what the people want, and what they will have, is a strong and durable concrete block with a beautiful face. And here I would also firmly impress this truth, that the face and the body of the block must be made at one simultaneous operation and the face matter must be so imbedded into the coarse concrete that it becomes an integral part of the block, and there must be no distinct line of cleavage between the face and the body. I wish you would memorize that; it is perhaps the most important sentence in this paper, and the number is legion who have dearly paid to learn this truth.

Now, as to various forms of face, the smooth even face is always elegant, but if without contrasting ornamentation it becomes monotonous. The pitch face, commonly called "rock face" by all block makers, is to-day the most popular design, principally from force of habit. I cannot believe that it will ultimately endure, as it nearly always appears to be what it is—an imitation. When the manufacture of concrete blocks was in its infancy, a man whose name is known to very many readers of this article as an eminent authority on cement matters remarked to me, "What you want is a face that will survive, and that face will be chiseled or ribbed with a bevel edge, because it has a genuine look." He was right. That is the face that is daily growing in favor. The popular demand of the day is for genuineness. That is destined to be the face of the future. That is the face which will get business, which will keep business, and which will increase business. Then there are various ornamental faces; nearly every plate manufacturer produces a greater or less variety. Into the merits of these I shall not go. Prepare yourself with a reasonable variety, in order to meet the demand, but don't get into the "gingerbread" habit—it lacks elegance. And don't, without advising to the contrary, allow a customer to select a design of which he will tire in a month.

Now, as to colored facing, it is simple. Almost any color may be produced by mixing dry mineral coloring matter with the face matter. Vegetable colors should never be mixed with cement. Reputable manufacturers now produce colors from iron pigments, especially adapted for this purpose, furnish them at reasonable prices, and supply complete instruction as to mixture and methods. A quarter or three-eighths inch face properly colored and properly applied will produce a beautiful stone practically unchangeable and everlasting.

G. W. Stevens.—In making colored blocks the following colors may be used: The proportions

given should vary according to circumstances, different materials giving different colors. There is one coloring matter that is a benefit—that is lampblack; all other colors are more liable to be an injury than a benefit. In mixing it is best to mix your coloring with the sand. The barrel to be used for measuring should be the size of a cement barrel. To obtain blue, use 3½ lbs. of ultramarine blue to one barrel of sand; dark blue, 1 lb. of Germantown lampblack. For red use 10 lbs. violet oxide to one barrel of sand; if a small amount of lampblack is used the color will hold better but will be changed. For buff, use 5 to 7 lbs. of yellow ocher per barrel of sand, and for brown use 6 lbs. of brown ocher to a barrel of sand.

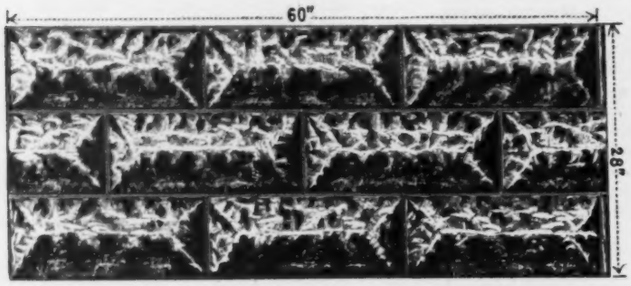


FIG. 1. STAMPED METAL FORMS FOR PITCH-FACED WALL BLOCKS.

By using the coloring judiciously the blocks can be made so that no two stones will be alike. The way to do this is to mix and wet two different kinds of facing; they can be both colored or one can be without coloring. Spread out one mixture an inch or two thick, then put the other on top of it, give the two a light turning and use as facing. Another way is to put a little of one mixture and then a little of the other into the mold.

Fig. 2. Stamped Metal Forms for Pitch-Faced Column Blocks.

H. H. Frantz.—The coloring of concrete blocks can, as a rule, be accomplished only at the expense of loss of strength, with the possible exception of red, which may be secured by the addition of finely ground oxide of iron mixed with the facing cement.

H. G. Richey.—In making concrete blocks the manufacturer should be able to imitate or match any of the various natural stones; this can be done by using the proper coloring materials. All coloring materials should be the best to be obtained, and should be used carefully, just enough being used to give the desired shade. The coloring material should be measured very carefully so as to get every batch of mortar or concrete of the same shade. The following is a list of the most common coloring materials used and the amount to be used with a barrel of cement. Of course, these quantities will vary according to the color of the cement used and the color of the block desired. Usually coloring materials will lessen the strength of the mortar or concrete so no more than necessary should be used; this is especially so of the ochers. To color black, use 45 lbs. of manganese dioxide to a barrel of cement; brown, 25 lbs. of best roasted iron oxide, or 15 or 20 lbs. of brown ocher per barrel of cement; blue, use 19 lbs. of ultramarine to a barrel of cement; buff, use 15 lbs. of ocher to a barrel of cement, but this will greatly reduce the strength of the block; green, use 23 lbs. of greenish blue ultramarine to a barrel of cement; gray, use 2 lbs. of Germantown lamp black (bone black) to a barrel of cement; red, use 22 lbs. of raw iron oxide to a barrel of cement; bright red, use 22 lbs. of Pompeiian or English red to a barrel of cement; purple, use 20 lbs. of Princess metallic to a barrel of cement; violet, use 22 lbs. of violet oxide of iron to a barrel of cement; yellow, use 22 lbs. of ocher to a barrel of cement. Ultramarine is one of the best coloring materials, as it does not affect the strength of the cement. Germantown lampblack is also good on account of the small quantity necessary to give a good color. Do not use common lampblack or venetian red as they are liable to run and fade. In coloring blocks the wet mixture should be colored several shades darker than that desired in the finished block, as the wet mortar looks darker to the eye (owing to the gloss of the water) than it really is. Concrete blocks should not be too dark as this is contrary to nature; all natural stones are of a light color or shade, thus in making a concrete block it should be given tone rather than color. The sand used for the colored mortar should be perfectly dry and the cement, sand and coloring matter mixed thoroughly before being wet. Various shades and colors can be obtained by the use of different cements; for instance, a blue cement used in connection with light colored sand will produce a light blue block. Experiments should be made with the various sands and cement to be obtained so as to know what colors of stone can be produced without the addition of coloring matter.

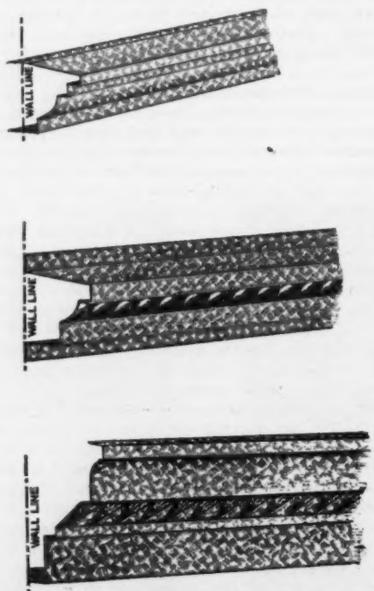
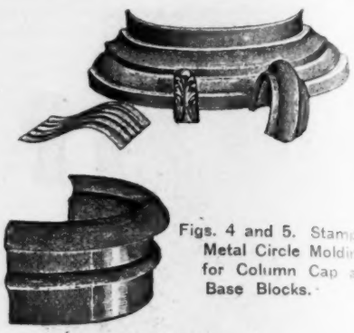


Fig. 3. Stamped Metal Forms for Cornice Blocks.

Joseph Babiczky.—Facing and coloring for cement blocks have been much discussed. I can see no reason why rock face has been used so much. Concrete blocks are too fine grained and too uniform in color to have such a face applied to them. Smooth or flat tooled faces are more suitable to the material. Facing blocks with an extra rich mixture to make them waterproof results in too smooth a surface; if any facing is used it should be made with crushed granite or marble. This gives a fine effect and does not cost much more than colored faces, which can be obtained by adding different mineral colors to the concrete.

U. G. Hayne.—In using coloring matter, mineral colors are the safest. Take the proportion of the coloring decided upon and mix it and the cement thoroughly, then add the necessary sand and mix all together until of a uniform color, then add water and mix until of a uniform color and of the wetness desired. For a black stone, take 1 cu. ft. of cement and 2 cu. ft. of sand, to this add 3 lbs. of excelsior carbon black; for a gray stone add 1 lb. of excelsior black to the above quantity of sand and stone. Using the same quantities of cement and sand add for the following colors: Dark blue, 4 lbs. ultramarine blue; brown, 4 lbs. brown ocher; bright red, 7 lbs. English red; red, 5 lbs. violet oxide of iron (raw). Coloring matter should be used sparingly as much of it is detrimental to the setting of the cement.



Figs. 4 and 5. Stamped Metal Circle Moldings for Column Cap and Base Blocks.

Ornamental Work.

H. H. Rice.—Of ornamental work I would say, leave it to a specialist. It is possible to produce most beautiful figures in cement work by simple processes, but poor ornamentation is an abomination, and a high degree of skill is required to obtain effects really artistic. In every manufacturing center you will find factories exclusively devoted to this branch of the cement industry. If you value your peace of mind or care for your profits you will, until you have acquired skill through long experience, give to such a factory the contract for that part of your work.

H. G. Richey.—For making special molds for rock face work sheets of stamped metal in imitation of rock face can be procured at little cost, as shown by Fig. 1, and this can be cut and shaped to make any size block desired. This metal can be procured in blocks of various sizes and also in lengths of 5 ft. and from 6 to 12 ins. in width. These stamped shapes can also be procured for making piers, porch columns, etc. Fig. 2 shows stamped metal suitable for this work.

Molds for the nosing and molding of steps can also be made in sheet metal, and a step of this kind will look much better than a plain one. For making molds for cornices, moldings, etc., stamped and bent sheet metal can be used as shown by Fig. 3.

These members can be got in any size and shape desired and up to 8 ft. in length. Circle molds as shown by Figs. 4 and 5 are also made in stamped or spun metal, and make excellent molds for bases and caps of columns.

Spun ballusters in sheet metal can be cut apart and used for molds for casting cement ballusters. In cutting the molds for circle work they should be cut in three pieces so as to be more easily removed from the cast stone.

Special molds for ornamental work of all kinds can be made from stamped metal. The metal when stamped in one piece can be used direct as a mold for ornamental work, or if the design is made up of several pieces of metal soldered together a mold can be made by taking an impression direct from the face of the metal ornament with a glue composition. In this way a mold can be made to duplicate any ornament de-

sired. This glue mixture for making molds for plaster or cement ornaments is made as follows:

Take the very best glue to be obtained, place it in cold water at night, the next morning take it out; when it will be found to be swollen. The water it has absorbed during the night is sufficient to melt it by heat; then mix as much glycerine with it as you had glue and keep the vessel containing them in a steam or hot water bath till the water is about evaporated, and till there is left as much in weight as the weight of the dry glue and glycerine taken together amounted to. This will make a compound of glue and glycerine which will never dry, and a mold of it can be remelted and used over and over again.

Fig 6. Stamped Metal Ornament Suitable for Ornamental Block.

The most intricate design can be made in these molds, and with a little practice the mechanic will be able to turn out ornaments and work to conform to or duplicate any architectural design and add a great percentage to the appearance of any building he may erect or furnish the blocks for.

Molds can be made in cement for plainer ornaments or moldings; the cement can be poured on the original and when hard can be removed, and this reverse impression of the ornament or molding can be used as a mold in which to cast the ornament. Before pouring on the cement the original ornament should be given a coat of linseed oil to prevent the cement from sticking.

After the cement mold is hard it should be given a coat of paint made by dissolving asphalt with turpentine or benzine. This will give the mold a smooth surface, which, if coated with a soap solution, will not stick to the cast.

In making molds or ornamental blocks several can be made along with the ordinary day's work, and in this way will not require a large number of molds for each design.

Figs. 6 and 7 are specimens of stamped metal suitable for ornamental molds; and Figs. 8 and 9 show a pilaster capital and a panel made of cement cast in glue molds as described.

Cement moldings can also be run in long lengths with a mold similar to that used in running stucco or plaster cornices; then the molding can be cut into the desired lengths.

To make a success of the concrete block business the proprietor must have mechanics who

Fig. 7. Stamped Metal Ornament Suitable for Ornamental Block.

will be able to make any special mold desired to reproduce the designs and ideas of the architect.

The past use of concrete blocks has shown and developed very little along this line, nearly all of the work done in the past has been confined to the product of machines and to an imitation of rock face work, and this is an imitation of the cheapest and most common class of stone work.

The reason of this has been that the majority of the molds furnished with the various machines have been for this kind of work only.

The successful block manufacturer must break away from this sameness of production and produce blocks in imitation of the better class of stone work. It costs no more to make blocks of this kind than those imitating the most common work except the cost of the molds and perhaps a little extra work, but this will pay in the end.

Take blocks made in an ordinary box mold, with the face trowled smooth as for sidewalks and you have a good imitation of rubbed stone and also a waterproof block; water does not go through a sidewalk simply because the face or top is troweled smooth and is made of a strong mixture of cement. To float the block off with a cork or wooden float and leave it a rough sand finish gives a very desirable effect.

A tool can be made of corrugated metal or of cast iron in the form of a trowel, which can be used on the face of the block and which will give a correct imitation of droved work on cut stone.

Blocks finished in this way are very pleasing to the eye as the small corrugations (about 1-4 in. apart) take away the gloss or smooth surface from the stone.

In the operation of a concrete block plant there will continually develop new ideas for making of molds and of ornamental blocks, and the man who is always on the alert to adopt new ideas which will assist him in turning out varied designs of blocks will be the one to succeed in the business.

The cement or concrete block houses of the past have not been designed by architects, but as a rule have been merely four walls built up and a roof put on them; but the concrete block house of the future will be designed by architects. Architects have been slow to take up concrete block construction for this reason, they have not been able to get their designs and ideas reproduced in the concrete blocks. It will thus be seen that the man who equips his plant in such a manner so as to be able to turn out blocks according to, and which will conform to the architects' sizes and drawings, will be the man to make a success of the concrete block business.

H. H. Frantz.—Ornamental faces may be had at but little additional expense by procuring stamped patterns of thick oiled cardboard, such as are employed by wall decorators in all cities. By placing one of these patterns in the bottom of the mold and filling the concrete on top of it its duplicate will be obtained on the block face after washing the cardboard off with hot water. Another very pretty effect can be easily produced by the employment of an ordinary sheet of paper and a stencil. Lay the stencil on the paper and apply a brush coat of glue, the pattern of the stencil will be produced in glue on the paper. On the wet glue sprinkle granite or marble chips or crushed glass of bright color and after the glue has become dry shake off all loose particles. Lay the paper face up in the molds and fill above with concrete. When the block has hardened and the paper has been washed off, the pattern will appear in marble chips or what not.

Special Blocks.

H. H. Rice.—I shall now consider the manufacture of a class of specialties which will greatly embarrass the operator if he be not prepared to meet the issue. I refer to such portions of a building as may fairly be grouped as sills, lintels, caps, coping, belt courses, arches and key stones. No machine of which I have knowledge, which may be truly characterized as a concrete block machine, is capable of satisfactorily producing these parts except in most limited sizes and designs. It is true some have attachments and others have cumbrous and unwieldy auxiliary machines of limited adjustability. In my opinion these attachments and auxiliary machines are made solely to sell, and do not embody the fundamental idea of mutual benefit as between manufacturer and operator. I have had a laborer, unskilled in carpentry beyond the use of saw and hammer, prepare from S-1-S boards molds for these things with most excellent results. They may be adjustable, too. The principle of their making is explained in the mold first described in the preceding section. If ornamentation is desired it is easily secured. If a molded belt course is needed, put a piece of stock molding in the bottom. If the demand be for arch blocks or keystones, ascertain the radius and cut the boards at the required angle. Put your face matter in first and back with concrete as wet as can be tamped. If sills or lintels are over 4-ft. in length, reinforce with an angle iron embedded in the concrete.

Fig. 8. Concrete Panel Cast in Glue Mold.

H. H. Frantz.—The production of special blocks is simply a matter of pattern making. Sills, caps, key stones and all the ornamentation of an architect's design can be readily executed in wooden molds.

THE NEW UNDERWRITERS' LABORATORIES Building at Chicago, Ill., has been completed and the necessary plant and fittings are being installed. These laboratories are under the direction of the National Board of Fire Underwriters. They are supported by the stock fire insurance companies doing business in the United States, and are engaged exclusively in experimental work in fire protection engineering and testing of devices and materials having a bearing on the fire hazard. This plant is the only one of its kind in the world and has grown to its present size and importance from a beginning made ten years ago in the establishment by the Western Insurance Union and the Chicago Underwriters' Association of a small room for testing electrical fittings on the second floor of one of the insurance patrol houses in Chicago. The new building was designed by Mr. Argyle E. Robinson, the Chicago architect and constructed under his direction and with the cooperation of the laboratory engineers. It is of fireproof construction throughout, walls solid brick, columns cast iron protected by tile, beams steel, floors reinforced tile (Johnson system), top flooring cement and endurite, window frames hollow metal, sash glazed with wired glass, and partitions reinforced tile in steel frames. There is absolutely no wood used in any part of the building or its fixtures with the exception of a 10,000-gallon wooden reservoir attached to the basement and this is kept filled with water connected to a 750-gallon electrically-driven fire pump located on the first floor. Walls and floors are all solid, no concealed spaces are used in interior finish and plant will be equipped throughout with most modern forms of automatic and manual extinguishing apparatus. The lot on which the plant is situated measures 100 × 100 ft., one-half of it being covered by the building and the remaining space, 50 × 100 ft., being reserved for yard purposes and for the erection of ovens for testing fire doors and shutters, floors, partitions and large subjects of this character. This 10,000 sq. ft. of land has been leased by the Laboratories' Corporation for a period of ninety-nine years. It covers 100 ft. street frontage on Ohio St. and extends 100 ft. in depth to a shipping alley between Ohio and Superior Sts. The location is north of the main

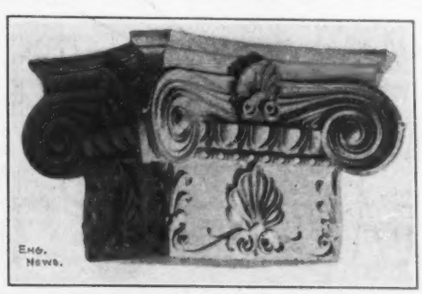


Fig. 9. Concrete Column Capitol Cast in Glue Mold.

branch of the Chicago River; is about 15 minutes walk from La Salle St., and is reached by electric and cable cars. This central location was judged necessary not only for easy access from the business district, but to secure connections of large capacity for supplies of electric current, gas and water essential in the laboratory work.

METHODS OF ROD-HOLDING IN STADIA SURVEYING AND DESCRIPTION OF A NEW STADIA SLIDE RULE.

By Arthur L. Bell, B. E., B. A., Assoc. M. Inst. C. E.

Two different methods of rod or staff-holding are at present in use by stadia surveyors, viz.: (a) that in which the staff is held vertically; and (b) that in which it is held at right angles to the line of collimation of the telescope. These systems may conveniently be termed "vertical" and "normal" respectively.

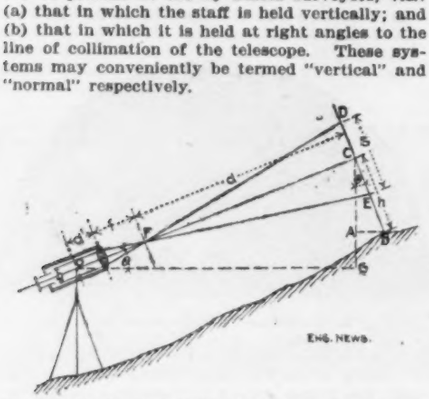


Fig. 1. Stadia Rod Held Normal to the Line of Light.

Fig. 1 represents a stadia instrument directed towards a staff DE held normally to the line of collimation.

Let b = distance between cross hairs in diaphragm.
f = focal length of object glass.
s = DE = space intercepted upon staff by cross hairs.
d = FC = distance of principal focus of object glass from staff.

O represents the axis of rotation of the telescope and F the principal focus of the object glass.

Because the rays pass through the principal focus F, they are parallel between the object glass and the cross hairs. Therefore by similar triangles:

$$\frac{d}{s} = \frac{f}{b}$$

$$\therefore \quad d = \frac{sf}{b}$$

The total distance required is (calling the distance from O to the object glass d'):

$$d' + f + d = d' + f + \frac{sf}{b}$$

But (d' + f) is a constant quantity in each instrument, and $\frac{f}{b}$ is likewise a constant ratio in any instrument with fixed stadia hairs. Denoting these constant values by c and k respectively we obtain the equation:

Total distance OC = c + ks = say R.

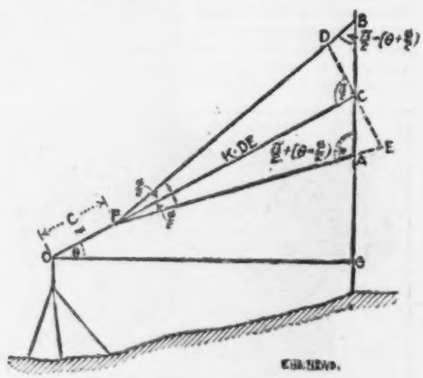


Fig. 2. Stadia Rod Held Vertical.

As a rule the surveyor desires to know, not the inclined distance OC, but its rectangular components, namely:

(a) the horizontal distance OG + AB
and (b) " vertical " GC − AC

Let θ = angle of inclination to horizontal of the line of collimation, then:

$$\text{Horizontal distance} = OG + AB = R\cos\theta + h\sin\theta \qquad (1)$$

and

$$\text{Vertical distance} = GC - AC = R\sin\theta - h\cos\theta \qquad (2)$$

These two equations are the general working equations of the normal system.

Fig. 2 represents the same instrument directed upon a vertical staff.

$$\text{Let} \qquad \phi/2 = \tan^{-1}\frac{b}{2f}$$

Through C draw a straight line perpendicular to FC and intersecting the rays FB and FA (produced) in D and E respectively.

$$\text{From } \triangle FCA, \frac{AC}{FC} = \frac{\sin\phi/2}{\sin\left[\frac{\pi}{2} + (\theta - \phi/2)\right]}$$

$$\text{From } \triangle FCB, \frac{CB}{FC} = \frac{\sin\phi/2}{\sin\left[\frac{\pi}{2} - (\theta + \phi/2)\right]}$$

$$\therefore AC + CB = FC\sin\phi/2\left\{\frac{1}{\cos(\theta - \phi/2)} + \frac{1}{\cos(\theta + \phi/2)}\right\} \qquad (3)$$

But

$$FC = \frac{DE}{2}\cot\phi/2 \qquad (4)$$

Substituting the value of FC given by equation (4) in equation (3) we obtain:

$$AC + CB = r = \frac{DE}{2}\cos\phi/2\left\{\frac{\cos(\theta + \phi/2) + \cos(\theta - \phi/2)}{\cos(\theta - \phi/2)\cos(\theta + \phi/2)}\right\}$$

$$= DE\cos\phi/2\left\{\frac{\cos\theta\cos\phi/2}{\cos^2\theta\cos^2\phi/2 - \sin^2\theta\sin^2\phi/2}\right\}$$

$$\therefore DE = r\left\{\frac{\cos^2\theta\cos^2\phi/2 - \sin^2\theta\sin^2\phi/2}{\cos\theta\cos^2\phi/2}\right\}$$

c and k, the instrument constants, being unchanged, the total distance

$$OC = C + k\,r\cos\theta - k\,r\tan^2\phi/2\sin\theta\tan\theta \qquad (5)$$

The horizontal component

$$OG = C\cos\theta + k\,r\cos^2\theta - k\,r\tan^2\phi/2\sin^2\theta \qquad (6)$$

The vertical component GC

$$= C\sin\theta + k\,r\cos\theta\sin\theta - k\,r\tan^2\phi/2\frac{\sin^2\theta}{\cos\theta} \qquad (7)$$

The expressions involving the square of the small quantity tan $\phi/2$ may be neglected, and we thus obtain what may be termed the working equations of the vertical system, viz.:

Horizontal component, or "distance on plan,"

$$= C\cos\theta + k\,r\cos^2\theta \qquad (8)$$

Vertical component, or "height above instrument axis,"

$$= C\sin\theta + k\,r\frac{\sin^2\theta}{2} \qquad (9)$$

The last equation gives the height of the point C. To obtain ground level, the reading of the instrument axis must be subtracted from the value given by equation (9).

Both the systems described (vertical and normal) give correct results if the staff be held truly vertical or normal.

A plumb-bob or bubble tube attached to the staff may be used to enable the assistant to hold the staff vertical.

In the normal system to ensure that the staff is being held truly normal to the line of sight the author uses the instrument shown in Fig. 3. This instrument, sold by Messrs. J. Halden & Co., of Manchester, may be made in various sizes, but the dimensions of that shown in the illustration, which measures 5¼ ins. in length when open, are considered sufficient for the accuracy required in ordinary surveys.

The cross wires in the open telescope enable the assistant to hold the staff in the correct position; and the surveyor can always check the accuracy of the staff-holding by observing whether the white disc at the back of the telescope close to the assistant's eye is, or is not, wholly obscured. The possibility of checking in this way the accuracy of the staff-holding is a point very much in favor of the normal system.

As surveys have often to be made in stormy weather or with staff-holders whose reliability may be doubted, it will be interesting to compare the errors introduced in the two systems under discussion by the staff being held out of its proper position.

Let Fig. 4 represent two leveling staves held out of their respective (vertical and normal) positions in each case by a small angle . It has been stated that the terms in equation (5) involving tan $^2\phi/_2$ may be neglected, and that the inclined distance OC (Fig. 2) = c + k[illegible]. It will readily be seen that this is equivalent to assuming that the upper and lower rays FB and FA are parallel when they impinge upon the vertical staff. Proceeding then upon this hypothetical assumption it is easy to show that the error in the vertical will be much greater than in the normal system for equal errors in staff holding.

Let θ = angle of elevation of line of collimation.
α = angle of error in each case.
R = distance read upon normal staff by stadia.
k = constant ratio of stadia $\left(\frac{f}{b}\right)$

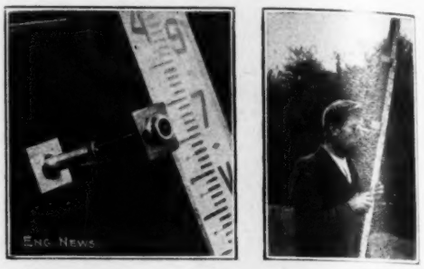


Fig. 3. Small Telescope Attached at Right Angles to the Stadia Rod.

It is required, to find the co-ordinates of the point O', the axes being rectangular and the origin at the center of rotation of the telescope (O in Figs. 1 and 2).

$$\text{Space intercepted on normal staff} = AB = \frac{R}{k} \qquad (10)$$

$$\text{Space intercepted on vertical staff} = CD = \frac{R\sec\theta}{k} \qquad (11)$$

But because the leveling staves are held away from their proper positions by equal amounts of angular displacement (α) the actual spaces intercepted are:

$$\text{On supposed normal staff:} - \frac{R}{k}\sec\alpha \qquad (12)$$

$$\text{On supposed vertical staff:} - \frac{R}{k}\sec(\theta + \alpha) \qquad (13)$$

In the belief that these are the correct readings the surveyor will, to find the horizontal component, multiply (12) by k cos θ and (13) by k cos² θ, thereby introducing the following errors:

In normal system. R sec α cos θ − R cos θ
In vertical system. R sec (θ + α) cos²θ − R cos θ

Taking an actual example in figures let

R = 1,000 ft.
θ = 30°
α = 3°

Error in normal system = 1,000 × sec 3° × cos 30° − 1,000 × cos 30° = 1.2 ft.
Error in vertical system = 1,000 × sec 33° × cos² 30° − 1,000 × cos 30° = 28.2 ft.

The reduction of stadia readings taken in the field may be effected by calculation, by the use of special books of tables, or by means of slide rules.

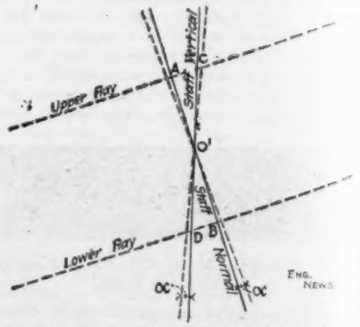


Fig. 4. Diagram Showing Effect of Errors in Holding Stadia Rod.

Professor Wild's special slide rule for use when the staff is held vertically is well known. The author has devised a special form of slide rule, Fig. 5, for use with a normal staff. It may, however, be used to reduce readings from a vertical staff. In general terms it may be described as a slide rule for solving, at a single manipulation, any right angled triangle.

It consists of two circular discs of cardboard or other material which revolve on a common central pivot. The lower, and larger, card is graduated clockwise to represent the mantissæ of the logarithms of the numbers 10 to 99. The dimensions of the card and the scales used are so related that the scale reads continuously. In other words, the mantissa of the logarithm of 10 corresponds with that of 1, a complete revolution of the card being equal to the characteristic + 1. It follows that the scale of the lower card represents not only the logarithms of 10 to 99, but

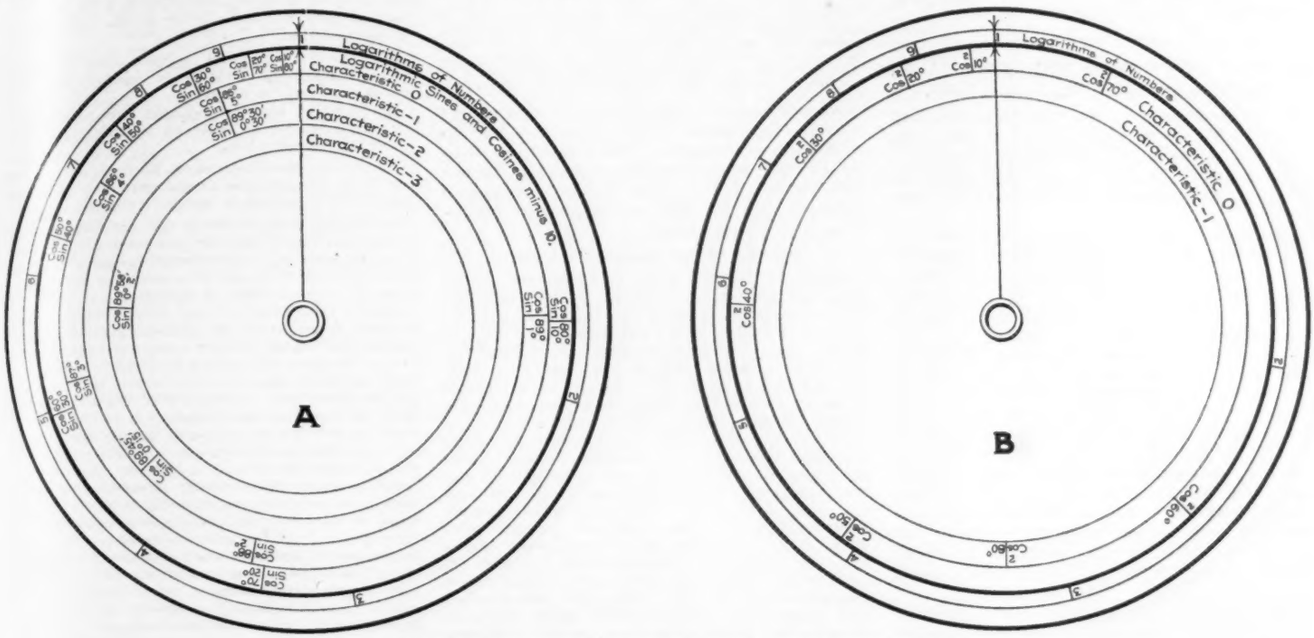


FIG. 5. CIRCULAR SLIDE RULE FOR REDUCING STADIA READINGS.

those of 100 to 999, 1,000 to 9,999, 1 to 9, 0.1 to 0.9, and so on.

The upper, and smaller, card is graduated (on the side marked A) to the values of the mantissæ of the logarithms of the natural sines and cosines. These values, being minus, read counter-clockwise.

To find the value of L × cos θ, it is necessary to add their logarithms together, thus:

$$\log. L + \log. \cos \theta = \log. \text{answer}$$

To obtain this result by the slide rule, set the arrow on the upper card (side A) opposite the value of L on the lower part, then opposite value of cos θ (as read on the upper card) will be found (on the lower card) the value of L cos θ. The value of sin θ is at the same time found opposite sin θ without moving the card.

The position of the decimal point, though frequently ascertainable by inspection, can only be determined in case of doubt by means of the characteristics. The characteristic of L follows the ordinary rules of logarithms, which are as follows:

(a) The characteristic of any number, greater than unity, is less by one than the number of digits, and is positive. (b) The characteristic of a decimal fraction is greater by one than the number of ciphers immediately following the decimal point, and is negative.

No such convenient rules, however, govern the characteristics of the logarithms of the cosines and sines, and these are, therefore, with their appropriate signs, given on the rule. The characteristic of the answer is equal to the algebraic sum of the characteristics of L and of the trigonometrical function.

N. B.—There is only one exception to the rules given. It has been stated that the scale of the lower disc not only represents the values of 1 to 9.9, but also 10 to 99, etc. If we place the arrow on the upper card (side A) opposite, for example, 102 ft., we find, opposite cos 30°, the horizontal component to be, by the rules of characteristics given, not 88.3 but 883.0. This is, of course, absurd, as the hypotenuse of a right angled triangle must be greater than either of the other two sides. We must, therefore, reduce by one the characteristic of L if, when reading counter-clockwise from L to find L cos θ or L sin θ we pass through the arrow on the lower card. This is equivalent to dividing the answer by 10, and the rule may be stated as follows: Divide the answer by 10 if, when reading counter-clockwise from the arrow on the upper card, the arrow on the lower card is found to lie between the arrow on the upper card and the logarithm of the angle.

The two following examples illustrate the use of the slide-rule (side A):

Ex. 1. To find the horizontal and vertical components of a length of 400 ft. inclined to the horizontal at an angle of 30°.

Place the arrow on the upper card opposite 400 on the lower card. (This is, of course, identical with 4, 40, 4,000, 40,000, etc.) Opposite cos 30°, shown on the upper card, will be found the value of the horizontal component, 400 × cos 30° = 34,640. Similarly, opposite sin 30°, is the vertical component, 400 × sin 30° = 20,000.

To find the position of the decimal point:

By rule (a) characteristic of 400 = + 3 — 1 = + 2
By note on upper card do. do. cos 30° = 0

Adding these characteristics together we find the characteristic of the answer to be 2. Hence by rule (a) there are three digits in the answer, which is therefore 346.4. In exactly the same way 400 × sin 30° is found to be 200.

Ex. 2. To find the vertical component of a length of 67.89 ft. inclined to the horizontal at an angle of 0° 30′:

Vertical component = 67.89 × sin 0° 30′. Place the arrow on the upper card opposite 6,789. Opposite sin 0° 30′ we read 5,924. The position of the decimal point is then found as follows:

Characteristic of 67.89 = + 2 — 1 = + 1
" " sin 0° 30′ = — 2
" " answer = — 1

By rule (b) the answer therefore is .5924, it being observed that the arrow on the lower card does not lie between the arrow on the upper card and sin 0° 30′. By the same rules we may find the value 67.89 × cos 0° 30′ to be 67.88. But, in this case, reference to the characteristics is unnecessary; as it is evident on inspection that, at such a moderate elevation, the horizontal component could not be either 6.788 or 678.8.

From the foregoing examples the use of the slide rule in the normal system will be readily understood.

It has been shown that (see equations 1 and 2)

Horizontal distance = R cos θ + h sin θ
Vertical " = R sin θ — h cos θ

R being the "distance read on normal staff + constant," h the height read on the staff by the central hair, and θ the angle of elevation (positive in elevation and negative in depression). The four values,

R cos θ, R sin θ, h cos θ and h sin θ,

are found by two separate manipulations of the slide rule.

When the reading has been taken from a vertical staff it is necessary to multiply by the square of the cosine of angle of elevation in order to find the horizontal component. To obviate the double shifting of the rule which this would entail, the other side of the upper disc (marked B) has been graduated to values of $\cos^2\theta$. Except in special work it will be sufficiently accurate to consider the constant c to be equal to c cos θ. This is practically the case unless the reading is taken at a considerable elevation.

The slide rule will be found very useful in reducing measurements in traverse surveys to northings, southings, eastings and westings, or in ranging curves with a stadia instrument; and, doubtless, in many other branches of applied science the ready finding of rectangular components will obviate much laborious calculation.

As most of our readers interested in stadia work are aware, circular slide-rule computers for reducing stadia observations are largely used in the United States. We submitted a proof of the above contribution to Mr. William Cox, C. E., who has designed a large number of slide rules for solving special engineering problems, including stadia computers. We requested Mr. Cox to make a brief comparison of the instrument designed by Mr. Bell and his own instrument, and append his reply below.—Ed. Eng. News.

Sir: I am in receipt of your favor of Oct. 23d inst., with proof of an article on stadia measurements.

The circular slide rule described, which is specially designed for use with a "normal staff," seems to me to be complicated by reason of there being only one scale representing the numbers 1 to 10, 10 to 100, 100 to 1,000, etc., like scales C and D of the Mannheim slide rule. There are also four concentric scales of sines and cosines, only one of which reads directly into the scale of numbers. It also involves that tedious work of ascertaining the position of the decimal point by adding the characteristics, etc., and requires results obtained to be in many cases divided by 10. All these operations are not only tedious but may be forgotten and lead to errors.

My stadia computer, on the other hand, consists of but one scale of numbers from 1 to 1,000, on the lower card, and a continuous scale of ½ sin 2 A and $\cos^2$ A on the disk reading into the scale of numbers. One operation only is necessary, that is to set an arrow on the disk opposite the rod reading on the lower card, when the difference of elevation and the horizontal distance are at once read off. There is no question of decimal

point and no multiplying or dividing by 10. Errors are impossible. It is designed for use with the rod held vertically, which is the usual method adopted in this country.

I should state that my stadia computer is the property of W. & L. E. Gurley, Troy, N. Y., the well-known makers of surveying instruments, for whom I have made several thousands of these computers. It was described and illustrated in your issue of April 5, 1900, as was also my stadia slide rule, constructed according to the same principles, and which is now the property of the Keuffel & Esser Co., of New York City.

Very truly yours,

Wm. Cox.

75 Broad St., New York City, Oct. 24, 1905.

AN EXPERT REPORT ON THE TRANSPORTATION AND HANDLING OF EXPLOSIVES BY RAILWAYS.

Most of our readers will recall the serious railway disaster at Harrisburg, Pa., in May last, when the explosion of a car load of dynamite in close proximity to an express train caused the death of 23 persons and injuries to over a hundred.*

That disaster called general public attention to the dangers in the transportation of explosives by rail, and led to the appointment by the American Railway Association of a committee to formulate a set of rules to secure greater safety in the handling of explosives.

This committee called in Dr. Chas. B. Dudley, Chemist of the Pennsylvania R. R .Co., as an expert adviser, and authorized him to bring to his assistance three other experts of the highest reputation. The three selected were Dr. Chas. E. Munroe, of George Washington University; Mr. Henry S. Drinker, President of Lehigh University; and Dr. Chas. F. McKenna, Consulting Chemist, of New York City. In addition, experts from the Army and the Navy were officially designated, the officers selected being Major B. W. Dunn, Ordnance Officer and Capt. A. R. Conden, U. S. N.

Besides the information obtained by the committee from these experts, circulars were issued and data obtained as to the regulations already in force upon American railways respecting the shipment of explosives, and inquiries were addressed to every State of the Union asking for statutes on the subject, to every city of over 100,000 inhabitants asking for municipal ordinances, and finally to manufacturers of explosives. The report of the committee continues:

From the information thus gathered, and now laid before the Association, your Committee feels that but one conclusion can be reached, namely, that a general code of regulations for the transportation of explosives must be adopted by our railways.

Protection to the lives and property entrusted to the care of our railway companies, requires the enforcement of proper precautionary regulations for the transportation of explosives, and justice to all manufacturers and dealers requires that these regulations shall be the same in all parts of the country.

From the regulations now in force on a number of railways, from suggestions received from various associations and manufacturers, and from the report of the sub-committee of experts as a basis, your Committee has compiled a set of Regulations for the Transportation of Explosives, which it herewith presents to the Association.

We print below a full abstract of Dr. Dudley's report to the Committee, and of the Report of the Committee of Experts. The Regulations compiled by the Committee, and approved at the last meeting of the American Railway Association (Chicago, Oct. 25, 1905), will be given in full reprint in our next issue.

REPORT OF DR. CHAS. B. DUDLEY.

QUESTION 1.—What is an Explosive?—The English Explosives Act defines an explosive as "every substance used or manufactured with a view to produce a practical effect by explosion, or a pyrotechnic effect." This, of course, covers commercial explosives. A broader definition of an explosive would be any substance or substances which, as the result of chemical change induced either by fire, by heat alone, by concussion or other causes, produce suddenly products which occupy more space than was filled by the substance before the chemical change took place. This definition, we think, covers all commercial explosives, as well as mixtures of coal gas and air, gasoline and air, mine gas and air, and many other mixtures which produce explosive effects when chemical change takes place. As an illustration it has been shown that a cubic foot of gunpowder generates when it is fired, 800 cubic feet of gases, and a cubic foot of nitro-glycerine generates when it is fired, 10,400 cubic feet of gases. This increase of volume is what makes explosives valuable, and, looked at from the practical standpoint, that explosive does the most work which creates the greatest volume of explosive products per cubic inch or cubic foot of explosive, as the case may be, when the explosive is fired. Its suitability for any given kind of work is determined by the velocity with which this change in volume takes place.

Question 2.—Classification of Explosives.—The English Explosives Act classifies explosives under seven headings. In this country our classification has not been made quite so elaborate. Most of the explosives covered by two of the headings of the English Explosives Act are covered under other headings. The classification which seems to fit our conditions here for transportation purposes is as follows:

(a) Black Powder.—This covers gunpowder, blasting powder, cannon powder, and both the black and the brown prismatic powder. It may also cover special mixtures containing constituents equivalent to those of black powder. It is well known that black powder is a mixture of nitrate of soda or potash, sulphur and charcoal. Sometimes other nitrates are used, such as nitrate of barium, and sometimes other constituents are introduced, as for example, pulverized soft coal, especially where the material is to be used for blasting. All such mixtures, which in the English Explosives Act are called "Nitrate Mixtures," are covered here under the heading "Black Powder."

(b) High Explosives.—This does not include ammunition, fireworks, or forbidden explosives, but does include every explosive stronger than ordinary black powder, except smokeless powders, fulminates and wet gun cotton. Almost all these high explosives rely for their strength on nitro-glycerine. Some of them, however, are of different composition, and contain no nitro-glycerine, but it makes a convenient distinction to rate as high explosives every explosive that is stronger than black powder, except as above noted. The English Explosives Act classifies nitro-glycerine and smokeless powders under the same general heading, but as the two do not behave alike under the conditions of transportation, and especially in their sensitiveness to shock, we deem it advisable to make a distinct heading for the smokeless powders.

(c) Smokeless Powders.—Under the head of smokeless powders are included all powders which give very little or no smoke when they are exploded. These embrace wet gun cotton, smokeless powder for army and navy use, and many of the smokeless powders for rifle and shot gun use made from wood pulp or from nitro-cellulose, as well as some of the picrate powders.

(d) Fulminates.—Fulminates, of which there are a number, fulminate of mercury being the most common, are largely used for firing other explosives. All the fulminates are sensitive to shock, and give a very vicious explosion even in very small amounts. While fulminate of silver is more sensitive than fulminate of mercury, probably 99½ per cent. of all the fulminate used in this country is fulminate of mercury. Fulminates are usually transported in small quantities.

(e) Ammunition.—Ammunition embraces in general those explosives where the materials necessary for one firing are covered in one piece. The largest portion of the ammunition transported is for fowling pieces and rifles, and this material is not especially hazardous. For government use, however, there is a good deal of fixed ammunition transported which is more hazardous, and this gives the necessity for certain regulations in its transportation.

(f) Fireworks.—Fireworks embrace everything ordinarily so called, and include track torpedoes, fuses and colored fires used for signals.

(g) Forbidden Explosives.—Liquid nitro-glycerine and dry fulminates should under no circumstances be accepted for transportation.

Question 3.—Characteristics of Explosives.—Since our field is the transportation of explosives, what is said on this subject is confined to that feature of the case.

We think it perfectly safe to say that every explosive that is used may be fired by heat alone, that is to say, if any explosive such as gunpowder, dynamite, fulminate, smokeless powder, or any other substance used to produce an explosive effect, is heated in any convenient vessel, as for example a small crucible, without access of flame or fire, when the explosive reaches a certain temperature it goes off even though, as already stated, no fire or flame has touched it. The temperature at which explosion takes place due to heat alone has been studied a good deal, and differs with different explosives. With the nitro-glycerine compounds it is about 360° F. With the material that is in the ordinary track torpedo it is about 280° F. With fulminate of mercury it is 374°, with fulminate of silver it is 266° F.; other examples might be given. This tendency to explode due to heat alone is an extremely important matter in the transportation of explosives, and when a new explosive comes forward one of the first questions asked is "what is the temperature of explosion due to heat alone?" This matter will be readily understood by supposing that a car load of dynamite, for example, gets in a wreck and fire results. Now it is entirely possible to burn up unconfined dynamite in small amounts without an explosion, but when a large amount is together, as in the case of a car load, or even a portion of a car load, the fire acts on the outside, as will be readily understood, and the heat from the fire penetrates the mass, raising the temperature until the explosive point of the material inside the mass is reached long before it can burn. Most of the accidents in the transportation of nitro-glycerine explosives have resulted from this cause. Some authorities are inclined to the belief that certain explosives, such, for instance, as those composed largely of nitrate of ammonia, mixed with nitro-substitution compounds or other combustible substances, but containing no nitro-glycerine or other nitric-esters, will not behave in this way. Commercial examples of explosives for which this is claimed are Masurite, Joveite and Arctic Powder. Smokeless powders are believed only to burn with an intense heat unless they are confined. An accident with black powder usually results in a scattering of the packages due to the explosion of some of those on the outside. Nevertheless it still remains that the most hazardous feature of the transportation of explosives is fire and the heat produced by fire.

Black powder is not like high explosives, sensitive to shock. It is claimed that fire from some source must be communicated to black powder before it will explode. The most violent explosions with black powder are produced by the high grade sporting powders. Their action is much more rapid than either the blasting powders or the prismatic powders. The blasting powders are large grains, usually of irregular shape, and burn comparatively slowly, serving their purpose, however, very well. The hexagonal powders used for large guns vary in their velocity of combustion quite considerably. The brown prismatic powder is quite slow in its burning, this being essential if rupture of the guns would be avoided. The black prismatic powder is much more active, and every gun charge contains a little black for priming and a good deal of brown. We have never known of an explosion of a car load of black powder due to heat, as has already been described for the nitro-glycerine powders, from the fact that as soon as the fire gets at some of the kegs they explode and scatter the rest. In one accident on the Sunbury Division of the Pennsylvania Railroad a wooden keg containing 25 pounds of black powder was blown a distance of 3,000 feet and recovered intact. The principal danger in the transportation of black powder is two-fold, namely, leaky kegs and fire (either a spark or general fire produced by a wreck) getting at the material. It may not be amiss to state that in the actual use of almost all explosives, they are fired by either fuses or detonators, fuses being very commonly used with black powder, and detonators with high explosives. The detonators contain fulminate of mercury and

*The circumstances of the accident as recorded in the quarterly bulletin of the Interstate Commerce Commission were as follows:

"Derailment No. 14 was that of a passenger train running at high speed striking a freight car, which had been derailed and pushed upon the track from a train on an adjoining track, in consequence of another accident, which had occurred a few seconds before (derailment No. 3). The first derailment was that of the 35th car in a freight train of 68 cars. This train, moving at about 6 miles an hour, was signaled to stop, on account of the presence of another train on the line ahead. On sighting the stop signal the engineman applied the brakes by reducing the train-line air pressure about 5 lbs. per sq. in. The grade of the road was level, or very slightly descending, but the air brakes were in operation on only half of the cars of the train (34), and the pressure of the other 34 cars, not air braked and therefore not retarded, against the forward half of the train was so severe that the 35th car was derailed and, with the 36th car, was pushed to one side. It does not appear that these cars were badly crushed or their contents much broken. The engine of the passenger train, striking these cars, was wrecked, and the fire in its fire box was scattered about the wreck. This fire ignited illuminating gas escaping from ruptured tanks of the passenger cars, and the fire, either from the coals or from the gas, exploded a large quantity of blasting powder, which was in the 36th car of the freight train, and this explosion created great havoc throughout the wreck and the adjacent cars of both the passenger train and the freight. Twenty passengers, 2 trainmen, and 1 other employee were killed, and 103 passengers and 7 employees were injured. Those cars of the passenger train which were not wrecked by the explosion were consumed by the fire, and many of the freight cars were destroyed in the same way.

"It will be observed from this abstract of the railroad company's report that this distressing accident was due to the lack of power brakes on the rear half of the train. This main cause may or may not have been reinforced by excessive slack between the cars, or by putting together in the same train cars of different degrees of stiffness and strength. It is not, however, deemed important to further analyze the cause of this accident, as it is very generally agreed that the only safe rule for the management of very long freight trains, as regards this question, is to require a large percentage of the cars to be power-braked, to keep the cars in the best possible condition as regards slack in the draft gear, and to avoid putting light or weak cars in front of heavy cars in the same train.

"In regard to explosives, it is universally recognized that their presence in large quantities in a railroad train is an imperative reason for exercising extreme care in the management of such train. The railroad company on whose line this disaster occurred and one or more other companies have now adopted regulations containing elaborate rules forbidding the transportation of explosives in large quantities except in trains of not over 30 cars, two-thirds air-braked. The explosives must be near the middle of the train and not within 10 cars of the front end, and must be in cars with steel underframes and air brakes, and which are known to be sound, by special inspection."

produce both shock and fire, and may be used with any kind of an explosive. Detonators should never be stored or transported with explosives.

The nitro-glycerine powders are all sensitive to shock. It is fair to state, however, that since liquid nitro-glycerine is not transported at all, and since the form in which nitro-glycerine is carried is with the nitro-glycerine absorbed in some absorbent medium, such as sawdust, wood pulp, nitrate of soda, etc., the sensitiveness of the nitro-glycerine powders to shock is infinitely less than in the case of liquid nitro-glycerine. If the nitro-glycerine is properly made, and properly absorbed in a well-dried absorbent material, and the powder is made up into cartridges and properly packed in good boxes strong enough to prevent rupture of the boxes and consequent leakage of the powder while in transit, there is very little danger in transporting high explosives due to the ordinary shocks of transportation. It is quite possible to throw a box containing fifty pounds of almost any high explosive from a point fifty feet in the air down on rocks without causing an explosion, and individual cartridges can be thrown with full force of a man from any height upon rocks without doing anything more than to rupture the cartridge. Moreover, a properly made nitro-glycerine powder can be hammered on a wooden surface until the hammer head beds itself in the wood without causing an explosion, yet it may frequently be exploded even by a glancing blow of wood on wood. Furthermore, a properly made nitro-glycerine powder is rarely exploded by the first blow when it is laid on an anvil and struck with a hammer. The second blow usually causes explosion. We are clearly of the opinion that if the nitro-glycerine powders are properly made and properly packed in sufficiently strong packages, there is almost no danger due to the ordinary shocks of transportation. It is badly made nitro-glycerine, broken packages and leaky cartridges that usually produce the risk, due to shock, in the transportation of high explosives. Decomposing and deteriorated nitro-glycerine powders are dangerous to transport. Decomposing nitro-glycerine powders give off acrid, irritating fumes. It is difficult to fully describe deteriorated nitro-glycerine powder; but powders which have been stored for six months or more may be regarded as suspicious, especially if the boxes show excessive dampness from storage, or are mouldy. If the boxes show any oily stains, the powder is so deteriorated that it is certainly dangerous to transport. The risk due to fire has already been mentioned.

It may not be amiss also to mention one or two other characteristics of nitro-glycerine explosives. It is a well-known fact that if a box of cartridges or a single cartridge of nitro-glycerine powder is detonated within a few feet of another box of cartridges of the same, the firing of the one will fire the other, although there is apparently no contact between them. This is not, as might be supposed, a case of transmission of fire from one cartridge to the other, but it is the shock produced by the firing of one cartridge which fires the other. There are cases on record of the explosion of a magazine in one locality producing an explosion of another magazine some distance away. Such explosions are called "explosions by influence," and this fact has a bearing on the transportation of explosives, in that there is an increased risk in having several cars containing explosives in the same train.

We have mentioned above carelessly made nitro-glycerine. There is a critical point in the manufacture of nitro-glycerine which, if ignored, leads to no end of difficulty. As is well known, nitro-glycerine is made by pouring a stream of glycerine into a mixture of the strongest nitric and sulphuric acids. The whole mass is stirred during the operation, and as heat is generated by the chemical change the material is cooled by artificial means. The eye of the operator is kept on a thermometer which is in the liquid, and it is believed that many explosions which take place in the manufacture of this material are due to its being insufficiently cooled. As much as, and sometimes more than one thousand pounds are made in a batch. After this operation is completed it becomes essential to remove the remaining acid from the nitro-glycerine, and this is the important part of the whole process, as regards the safety of the finished product. The acids and the nitro-glycerine being of different specific gravities, this fact is made use of to effect their separation. The nitro-glycerine is then washed with water to remove the bulk of the acid adhering to it. It is subsequently treated with soda solution to neutralize any acid which may be left, and finally with another washing of water to remove the soda solution. If, now, this operation be properly performed and all the free acid be removed, the nitro-glycerine may be said to be well made and a safe material to proceed with. On the other hand, if all the acid be not removed, in the course of a short time, possibly a week or two and possibly a shorter time, the nitro-glycerine becomes changed in its properties and becomes infinitely more sensitive to shock. Such badly made nitro-glycerine is very hazardous to transport. To neutralize any possible traces of acid which might still remain after the washing or be produced by decomposition, it was formerly the almost universal custom to add to the absorbent material in nitro-glycerine powders a small amount of some substance called an ant-acid, such as carbonate of magnesia or zinc white. This practice has been abandoned by some, but it is of the highest importance that it should be resumed.

This is the place, perhaps, to mention a modification of nitro-glycerine explosive known as "gelatine dynamite." It has been found that nitro-cotton dissolves in nitro-glycerine, and that when the proper proportions of these two ingredients are mixed together they mutually dissolve each other and a material is formed which is even stronger in its explosive power than nitro-glycerine alone. The material becomes gelatinous and is mixed with absorbent in much the same way as ordinary nitro-glycerine, except that being gelatinous it is possible to use more of the explosive and less of the absorbent, thus making a much stronger powder. With the ordinary nitro-glycerine powders, the safe limits for transportation are sixty parts nitro-glycerine and forty parts absorbent. In the gelatine dynamite as high as eighty parts "gelatine" and twenty parts absorbent material may be used. This material behaves much like the ordinary nitro-glycerine powders, and although a stronger explosive, is believed, if properly made, to be fully as safe to transport as the ordinary nitro-glycerine powders.

A few words may not be amiss on leaky cartridges. As already explained, the nitro-glycerine in high explosives is absorbed in a mixture called a "dope," such as a mixture of wood pulp and nitrate of soda or other substances already mentioned. If the proportions of liquid nitro-glycerine and of absorbent are what they should be, there will be no danger of leakage of the nitro-glycerine, even during a warm summer day, but, unfortunately, during the last few years a change has taken place in the manufacture of high explosives. Formerly dry sawdust and nitrate of soda were the principal absorbent materials. Within the last few years ground wood pulp has been used, but wood cannot be ground after it is seasoned on account of the materials taking fire. Green wood must be used and green wood contains about 18 per cent. of water. Some of the manufacturers have not dried their wood pulp previous to mixing, and the moisture of the wood pulp has united with the nitrate of soda, which is a hygroscopic substance, liquefying it, and therefore diminishing the absorbent capacity of the dope. Furthermore, powders as high as 75 per cent. nitro-glycerine and 25 per cent. absorbent have been made. It will readily be understood that under these conditions the liquid nitro-glycerine may run out of the cartridges and indeed this is a well-known phenomenon. If, now, the liquid nitro-glycerine does exude from the cartridges and finally reaches the outside of the boxes, and gets between a nail in the box and a nail in the car floor, the ordinary shocks of transportation would fire the nitro-glycerine with the result of blowing up the car load. The skidding of the boxes over the floor may produce the same result. We are clearly of the opinion that the explosion at Crestline two years ago was due to the leakage of high percentage, carelessly made, nitro-glycerine powder.

Influence of the Weather.—Nitro-glycerine freezes at about 40° F. if exposed for some time to this temperature. In the frozen condition it is less liable to explosion from shock, and it has been proposed to transport nitro-glycerine powders in refrigerator cars. This does not seem to be advisable, however, for several reasons. The subsequent artificial thawing of these powders for use would probably increase their danger, as a whole. Moreover, their transportation in the frozen form would not result in entire freedom from accident, since fire following a wreck, as has already been explained, is the most frequent cause of disaster, and such fire would thaw the material and heat it locally to a sufficient degree to cause explosions. Furthermore, according to Hess, by long continued exposure to high temperatures, both volatilization and decomposition, in a greater or less degree, result. Nitro-glycerine begins to decompose at temperatures between 112° and 122° F. and decomposes quite rapidly at 158° F. Moreover, the tendency to leakage and also the sensitiveness to shock increase with the temperature. The increase in the temperature of a car, owing to exposure to the sun in very hot weather, tends to produce these results. It would seem to be advisable, when transporting these powders in warm weather, to have cars ventilated and to make the transportation in the hottest part of the summer as small as possible, and to have the cars on the road as short a time as may be.

Smokeless Powders.—Under this heading are two or three substances: Wet gun cotton, nitro-cellulose, smokeless powders for army and navy use, various wood powders, picrate powder, etc., which are used to a limited extent for sporting purposes. Gun cotton, as is well known, is made by immersing ordinary cotton fiber in a mixture of nitric and sulphuric acids. The nitric acid reacts with the cotton, forming a substance technically known as "Nitro-cellulose." This material in the dry condition can be fired readily by sufficient shock. In the wet condition it is very much less sensitive to shock, although if the shock is strong enough it is fired. Under the conditions in which it is transported, containing not less than 15 per cent. of water, there is almost no risk due to the ordinary shocks of transportation, and even in the dry condition such shocks will have no influence on it. It is quite sensitive to fire and burns with great violence and rapidity. The most important point in the transportation of this material is to have the material wet when received, and the boxes tight, so that the water will not evaporate during transit. Under these conditions there is very little risk. The smokeless powder for army and navy use is composed of nitro-cellulose dissolved in certain liquids and then the solvents evaporated. This leaves a material much like horn. It is moulded while plastic and cut into convenient lengths. The grains differ in size and often are perforated with holes to facilitate burning. This material is absolutely independent of shock so far as known. It is a query whether a car load of it would behave like nitro-glycerine powder under the influence of heat. The general consensus of opinion of experts is that a car load of this powder, exposed to fire, would result in a violent and rapid conflagration, but would not detonate, as a whole. The great risk in the transportation of smokeless powder is fire. The wood powders and the picrate powders, etc., need no special comment as they are similar to the smokeless or black powder in the matter of transportation. Fire is their great enemy. It should be mentioned, however, that picrates are sensitive to shock.

Fulminates.—Fulminate of mercury is made by the reaction taking place between a solution of mercury in nitric acid and grain alcohol. As the reaction goes on the fulminate separates out from the liquid as a grey crystalline solid. This material when dry may be fired by fire, heat, friction, concussion or shock, and, however fired, it always undergoes a detonating explosion. It may even be fired when saturated with or submerged in water if some dry fulminate be detonated in contact with it. It should never be transported in the dry condition in quantity, and in transporting wet fulminate extreme care should be taken that no portion of this wet mass, however small, is allowed to become dry. Fulminate of mercury is the characteristic component of detonators, blasting caps or dynamite exploders, and they are essential for use in firing dynamite and other high explosives. Owing to the U. S. Internal Revenue tax on grain alcohol very little fulminate of mercury is manufactured in this country, and consequently this necessary substance must be imported in considerable quantity.

Detonators, blasting caps and dynamite exploders should never be transported or stored in the same car or compartment with other explosives or with inflammables, and they should be carefully protected from fire, heat or shock, or contact with acids. It should be borne in mind that fulminates are the most sensitive of the explosives commonly met with, and the most violent.

Ammunition.—There have been a very large number of experiments made, indicating that small-arms ammunition for pistols, rifles and fowling-pieces is not at all liable to explode "en masse," even when fire gets among a car load of it. Indeed, it is claimed that a basket full of cartridges has been poured on a fire in an open grate without damaging result. The Winchester Repeating Arms Company has recently made some very elaborate experiments on this point, and the results indicate that the only risk in transporting small-arms ammunition is loss of the commodity in case of wreck or fire. On the other hand, when larger pieces of ammunition are stored together, and one of them is fired from any cause, the whole mass explodes. Some very elaborate experiments were made by the Inspector of Explosives of Great Britain some years ago on this point, and he found that if a box containing a number of shells of great-gun ammunition were so fixed that one of the shells could be fired by electricity, all the shells in the box did actually go off "en masse." Moreover, it will perhaps be remembered that an artillery caisson exploded, "en masse," in the streets of Chicago a few years ago, due to a jar firing one of the shells in the caisson. As the transportation of great-gun ammunition is generally for the Government, and as it is presumed that every possible precaution is taken in packing, the risk is undoubtedly small, except as has been already emphasized a number of times in case of a wreck or fire, there would undoubtedly be an explosion. Furthermore, since such fixed ammunition has within itself the means of firing, if, as the result of a wreck, some of the shells should be set off by shock, it is undoubted that a disastrous explosion would follow.

Fireworks.—The characteristics of ordinary fireworks are so well known that it is probably waste of time to say much in regard to them. Fire is their great enemy in transportation, and we have never known of an accident due to shock. The explosive materials they contain are largely gun powder, or gun powder-like mixtures which give colored fires and sometimes fulminates in minute quantities. Some of the materials used and some of the mixtures employed in fireworks have given rise to spontaneous combustion. This has sometimes been found to be due to impurities in the constituents, and sometimes to a badly designed mixture. The material in railroad track torpedoes is chlorate of potash, sulphur and gravel or sand. They are quite sensitive to shock individually and also are readily fired

by heat alone. Instances have been known of firing taking place in track torpedoes, from their slipping down a heated radiator in a car. Care should be taken that the sulphur used in their manufacture is wholly free from acid. Packed as they are, ten gross in a package, without any special shock coming to the individual torpedoes, we do not think them especially hazardous to transport. The ordinary railroad fusee often gives rise to fires during transportation and storage. These fusees are unusually strong paper tubes, filled with a mixture of some combustible substance, with such nitrates as will give the colored fire desired. These fusees are probably not explosive, either by fire, heat or shock. The fires usually start from the ignition appliances attached to them. Some fusees are ignited by breaking a bulb of sulphuric acid and some by arrangement similar to that used in the safety match. The former are very hazardous, as the sulphuric acid bulb is easily broken. A number of cases of fires are on record due to the rupture of this bulb, owing to the fall of a box of these fusees, or indeed to the customary handling in loading the boxes on a truck. The use of fusees with this method of ignition should be discouraged. Toy torpedoes, sometimes called "throwdown" torpedoes, may give rise to difficulty if improperly packed, or of extraordinary size.

Question 4.—A list of the manufacturers of explosives has been prepared from the best data at our disposal. The sources of the information are the Census Office Reports, and some special reports made by the Powder Trust, and by some employees of the Pennsylvania Railroad Company, who have given special attention to the transportation of explosives on its lines. The list is undoubtedly defective, and there is probably some duplication. It will be a work of some time to get this list perfected. Taking the list as it stands, we find 165 establishments in the United States manufacturing explosive materials of various kinds. Of these 57 are located in Pennsylvania; 20 in New Jersey; 11 each in California and Ohio; 10 in New York; 7 in Michigan; 6 each in Illinois and Indiana; 4 each in Alabama, Connecticut, Missouri and West Virginia; 3 in Tennessee; 2 each in Delaware, Iowa, Kansas, Kentucky, Maine, Maryland and Massachusetts, and one each in Rhode Island, Vermont, Virginia and Wisconsin. It will be noted that by far the largest percentage of explosives manufacturers are in the Eastern States. This is probably due to the fact that, as claimed, for every pound of finished explosive sent out, three pounds of freight, in the form of raw materials, go into the manufactory. As nitrate of soda and sulphur are both imported products, and as glycerine itself is largely an imported product, all of these being raw materials used in the manufacture of explosives, it is evident that the saving in freight by the location of the works in the East or near the seaboard, would be quite considerable.

Question 5.—Practices of Manufacturers in Handling Explosives to Avoid Accidents.—Not very much can be said on this subject that is applicable to transportation matters. The manufacturers after the explosives are made only have to handle them from the magazine or shipping house to the freight station or siding, where they are loaded in cars. This carrying is usually done in wagons, and cases are known where blankets were spread on the bottom of the wagons to relieve the shock due to the jolting produced in going over rough roads. This is especially true when materials have been returned to the works to be remade. It is a well-known fact that all explosives deteriorate on standing, and sometimes the railroads are asked to take deteriorated explosives from local magazines distributed throughout the country back to the original works to be remade. Of course, in all establishments manufacturing explosives great care is taken to avoid fire, to avoid high temperatures, and to avoid shocks, these three being the principal causes of accident. It is claimed that only very careful men, who have had experience and are strictly trusty, are ever employed to handle the finished explosive. In putting the cartridges in boxes at the works they are sprinkled over with sawdust after the box is filled and then the boxes are nailed up in the regular way. The parties doing this work seem to have no hesitancy, and do not seem to fear any danger from the nailing, and, as a matter of fact, so far as our studies have gone, the accidents, especially in nitro-glycerine works, are more connected with the manufacture of the nitro-glycerine itself than with the handling of the powder after it is made. It is not rare for a nitro-glycerine house to be blown up. It is rare for a magazine to explode. It is customary to have several at a works so that all the product on hand shall not be involved in a single explosion. It should be mentioned, perhaps, that large mounds of earth are often thrown up about the danger buildings at the works in order to limit the extent of damage done in case of an accidental explosion taking place. Moreover, the different operations are separated as much as possible, the buildings being small and widely scattered, so that an accident in one part of the works will not involve the whole.

CHAS. B. DUDLEY.

Altoona, Pa., July 24, 1905.

REPORT OF COMMITTEE OF EXPERTS.

Gentlemen:—The undersigned, to whom, as an Advisory Committee, the consideration of regulations governing the Transportation of Explosives was referred, have the honor to report that—

(1) Your Committee finds the explosives industry in the United States to be of importance and continually growing in the quantity and value of its output. This is exhibited by the accompanying table, taken from Bulletin 210 of the U. S. Census for 1900:

(2) It finds that the important and extensive industries of mining and quarrying, the many industries which employ the products of mines and quarries, and engineering operations, cannot be economically or safely carried on without explosives.

(3) It finds that the well-being, comfort and advancement of our modern civilization is to a large extent dependent upon the utilization of explosive substances, and that the raw materials from which explosives are manufactured, the products of the mines and quarries made available through the use of explosives, and the great variety of articles manufactured from these products, constitute a considerable part of the freight carried by railroads, while the various industries that are fundamentally dependent on the use of explosives give employment to an enormous number of persons.

(4) It is of the opinion that the explosives industry is now so well established a feature of our industrial operations that its products must be transported and that the best interests of all will be conserved by their being publicly transported by the ordinary routes of travel under such restrictions and conditions as will protect the traveler and the carrier without unduly hampering the producer, dealer or consumer.

(5) It is of the opinion that a carrier has the right to know the character and properties of the goods he carries, for without such knowledge he may be unable either to protect such goods from injury or to so handle and transport them as to prevent their injuring persons and property. He should therefore be definitely informed regarding the composition and properties of all inflammables and explosives or of substances which may, by contact with other substances, form inflammables or explosives which he is called upon to transport. He also has a right to demand a guarantee that any consignment offered of an inflammable or explosive possesses the same or a higher degree of stability, both as regards its composition and its method of packing, as the previously accepted or standard substance of this class or variety possessed.

(6) It is of the opinion that explosives and inflammables should be started on their way as soon as possible, forwarded as speedily as practicable and promptly delivered, since the shorter the time they are in possession of the carrier the less the risk.

(7) To indicate somewhat the magnitude of the risk following the quantity of explosives shipped in a single lot your Committee submits the following table, compiled from a table prepared by H. M. Inspectors of Explosives and adopted by the United States authorities. In the original table, among other data, is given the distance which a magazine or factory containing the given weight of explosive should be separated from a public railway in order to protect the latter. The conditions we are considering here are the reverse of those named by H. M. Inspectors of Explosives, for the explosives are on the railroad and the distance becomes the danger radius about the car for dwellings, churches and other buildings.

Amount of Explosive.	Danger Radius.	Amount of Explosive.	Danger Radius.
3,000 lbs.	240 yds.	30,000 lbs.	1,200 yds.
4,000 "	280 "	40,000 "	1,525 "
5,000 "	320 "	50,000 "	1,850 "
10,000 "	525 "	100,000 "	3,500 "
20,000 "	850 "		

This danger radius is not the limit of final effect, for glass may be broken, walls cracked and weak structures shaken down at greater distances, depending on the topography and geology of the locus of explosion. On the other hand, these very features last mentioned may operate to materially diminish the danger radius. It should be said also that these data are derived from a discussion of data obtained in accidental explosions in the past and represent extreme conditions.

(8) Your Committee is of the opinion that the greatest danger which carriers have to contend with in transporting explosives is fire and that every effort should be made to protect such shipments from fire.

(9) It recognizes a second and more remote cause of danger in friction, percussion and concussion, and packages containing explosives should be handled and stored in cars with due precaution against these conditions arising. Freight handlers should know that the striking of a corner of a wooden box smeared with nitro-glycerine against the wooden floor of a platform or car might give rise to an explosion.

(10) It recognizes a third cause of danger in high temperatures, which may start or promote decomposition and facilitate leakage. The practical application of this is that it is more hazardous to transport certain explosives in very warm weather, and that they should never be placed near a source of heat.

(11) Holding the above expressed views, your Committee calls attention to General Notice No. 1749 of the Pennsylvania Railroad Company, dated August 1, 1905, being "Information and Regulations for Shippers and Employees," relative to the "Transportation of Explosives." In our opinion, these regulations are practicable, reasonable and fair, and, if observed, offer a high degree of protection and insurance of safety.

(12) Your Committee is of the opinion that the interests of all will be best advanced; that the danger to life and property will be reduced to the minimum; trade will be promoted and industries fostered by the adoption by all railroads of uniform regulations governing the transportation of explosives and inflammables, and we advise that such regulations be in general conformity with and on the lines of those now in force on the Pennsylvania Railroad as cited above.

(13) Taking up in greater detail the regulations, your Committee recommends:

(a) That, to guard against "so-called spontaneous combustion or explosion," no nitro-glycerine explosive, or an explosive of this class which gives an acid reaction, or which fails in the stability test, or which contains an insufficient amount of ant-acid, be accepted for transportation.

(b) That, as a precaution against leakage, cartridges or sticks of explosives be so packed in boxes that when loaded in cars the cartridges shall always lie upon their sides and never stand upon their ends.

(c) That containers be marked "Explosives—Dangerous" on all sides, and, to admit of the method of stowing recommended in (b), they be so marked that the position in which the cartridges lie is indicated.

(d) That, as a further precaution against leakage from the boxes and to reduce the chance of explosion by shock, cartridges or sticks be packed in dry sawdust or dry infusorial earth.

(e) That, as a precaution against explosion from friction, or shock, care be taken in loading explosives that the packages are so stayed or chocked in the car that they cannot shift or fall.

(f) That no inflammable, no detonators or blasting caps and no acids be shipped in the same car with explosives.

(g) That cars carrying explosives be strong box cars in good order and be fitted with air brakes and, in trains, be placed between cars fitted with air brakes.

(h) That cars carrying explosives be located so far from the engine as to reduce to a minimum the danger from sparks from the engine.

(i) That cars carrying explosives be followed in the train by several cars so as to reduce to a minimum the chances of explosion in case of a rear-end collision.

(j) That cars carrying explosives be widely separated in a train from cars carrying petroleum or naphtha. So far as possible cars carrying explosives and cars carrying petroleum or naphtha should go by different trains.

(k) That in making up trains no cars carrying pig iron, steel billets, heavy structural metal parts, machinery or other heavy material, which in a collision might crush adjacent cars, be placed adjacent to a car carrying explosives.

(l) That in view of the fact that explosives containing nitro-glycerine or other nitric esters are more liable to decomposition the higher the temperature, the transportation of these explosives should be limited as much as possible during the hottest months of the summer, and when transported in warm weather every available precaution should be taken to keep the temperature of the car as low as possible, such, for example, as wetting the car down at water stations.

(m) That it is essential that the containers should be so made and of such strength that they will not be broken in transit.

(n) That in the transportation of explosives containing a liquid component it is desirable that the containers be lined with a liquid proof lining.

Respectfully submitted,

CHARLES E. MUNROE,
HENRY S. DRINKER,
CHAS. F. McKENNA.

Philadelphia, Pa., Sept. 15, 1905.

TOTAL PRODUCTION AND VALUE OF EXPLOSIVES BY DECADES—1840 TO 1900.

Year.	Number of Establishments.	Capital.	Average Number of Wage-earners.	Products. Pounds.	Products. Value.
1840	137	$875,875	496	8,977,348	.....
1850	54	1,179,223	579	.....	$1,500,332
1860	58	2,305,700	747	.....	3,225,080
1870	36	4,099,900	973	.....	4,257,539
1880	54	6,585,185	1,340	.....	5,802,029
1890	69	13,539,478	2,353	98,645,912	10,993,131
1900	97	19,465,846	4,502	215,980,719	16,050,976

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The report of Dr. Geo. A. Soper on the sanitary condition of the New York subway, printed in this issue, fully corroborates—if corroboration were needed—the position taken by this journal, six months ago. The subway is hot because of the vast amount of electric power which is all the time being poured into it to run the trains, and which in the using is all transformed into heat. This heat makes the subway warm in winter; but uncomfortably hot in summer; and this condition is apparently inevitable, unless someone is willing to go to the enormous expense of installing some sort of artificial cooling plant for cooling the subway air. Barring some radical innovation of this sort, the best thing that can be done, apparently, is to increase by mechanical means the interchange of air between the subway and the street during the hot season. The subway air will inevitably be hotter on the average than the air in the street above; but by installing additional fans the difference between the two temperatures may be somewhat reduced.

As a possible means of reducing the amount of heat discharged into the subway, Dr. Soper suggests that instead of stopping the trains with the present brakes, the motors might be used as generators to restore current to the line, thus reducing the draft on the power station and the consequent amount of heat liberated in the subway.

In abstract theory, this is, it is true, a possible method of reducing the temperature of the subway; but as a practical matter, in the present state of the art of electrical engineering, there is absolutely nothing to be hoped for in this direction. It is true that electric railway motors can be made to act as generators, and are extensively so used as auxiliary braking appliances; particularly abroad; but when so used the current generated is generally consumed in resistances instead of being returned to the third-rail or trolley wire. This system of course would not help the situation at all. The same amount of current will generate the same amount of heat, whether the conversion is made by the friction of a brake-shoe or by the passage of the current through a resistance coil.

It is true also that systems have been used to some extent wherein the motors act as generators and return current to the line; but such systems are still more or less experimental and they require special motors and controllers. Further, all such motors when used as generators are very inefficient, averaging probably not over 50%. This is particularly the case when the motors are used to stop trains. In Europe, the chief use of the so-called regenerative system has been on mountain railways, where the motors are used as generators to control speeds on long down grades. In the subway, however, the chief use of the brakes is to stop trains at stations, and here the regenerative system would be exceedingly inefficient, since the motor would be generating current at speeds decreasing from the maximum to zero.

Suppose that of the total heat discharged into the subway as much as 50% is now dissipated from the brake-shoes (and this is probably much in excess of the actual amount). If it were possible to do all the work of checking trains with the motors acting as generators, with an average efficiency of 50%, we should have then a total reduction of 25% in the total heat liberated in the subway, and the total draft on the power station. Actually the reduction could not be as great as this; for the brake-shoes must do part of the work of stopping the train, even with a regenerative system of control. It would not be reasonable to expect even with the best system that could be devised, to reduce by more than 15 to 20% the amount of current used in the subway; and this would be too small a proportion to have any noticeable effect on the temperature.

While we are on the subject of the so-called "regenerative" system of controlling the speed of electric trains, it may be well to record two strong reasons which stand in the way of any general use of electric car motors as generators. The first of these reasons is the heating effect on the motors. As just noted, when the motor is made to act as an inefficient generator, half or more of the energy is expended in heating the motors. But the power or capacity of an electric motor is governed by its ability to stand heat. If the brake-shoes are used to stop the train, the motors can cool off while the train is slackening speed. If, on the contrary, the motors must work as generators while the train is slowing down, the motors must be designed to stand this excess of heat. This means larger and heavier motors; and it is difficult enough to get the present motors into the limited space available on a car truck. Besides, when the motor designer attempts to lay out a motor which shall not exceed safe temperatures when run as a generator to stop the train, he is confronted with such large unknown conditions that intelligent design is practically impossible.

The other reason against any and all forms of electric braking is the matter of safety. The brake is, first of all, a safety appliance. Its reliability must be beyond question. The simpler it is, the lower the percentage of failures that may be expected. Long experience has proved the present air brake system to be reliable and safe to a superlative degree. Could such results be expected from any system which required the action of as complicated a piece of apparatus as an electric motor run as a generator to effect retardation?

It may be said that the ordinary brakes could be kept for emergency use if a motor-generator braking system were installed; but experience has shown that apparatus used only for an emergency is too apt to be inoperative when the emergency comes. The far safer plan appears to be that which is at present in use, whereby the ordinary brakes are used for retardation in all ordinary cases; and in the rare event of the brake failing to respond, the operator can reverse the motors to check the speed.

The regenerative system of speed control must be admitted even by its most enthusiastic advocates to be in an experimental stage; and the New York subway is about the most undesirable place to have any experiments made in so important a matter as the speed control of the trains.

The waste of construction materials is often the cause of an entirely unnecessary increase in the cost of structures, and may generally be prevented or kept within reasonable limits by the exercise of a little forethought and oversight. In one particular case where some concrete work was to be done at the foot of a railway embankment, the sand and stone were shoveled from cars and thrown down the bank. Much of the stone was scattered in the ditch and among bushes, where it could only be recovered by hand picking, and still more lodged in the depressions on the face of the bank. It is probable that at least 10 per cent. was lost in this way and never reached the concrete. Of the sand a much larger proportion was lost in the same way, in addition to the effect of wind and rain in blowing and washing the sand away during the four or five weeks that the material lay unused. It would have cost but a very few dollars to build a couple of platforms or shallow bins of planks and also plank chutes up the face of the bank, so that the material might have been sent direct to the bins with a minimum of waste. But apparently nobody had thought of the matter, and the men simply unloaded the cars at the point directed. This work was not done by contract, but by the railway company's own forces, and if itemized cost records are kept, the actual cost of concrete will probably be considerably in excess of the estimated cost due to extra material being required. Since this particular case was noted, other similar works have been examined and waste of the same kind observed. A contractor would, as a rule, be more careful, but even on contract work the same waste and carelessness are very frequently to be observed. This is one of the many small leaks through which disappear the contractor's prospective profits.

We illustrate in this issue a new application of the steam turbine which may be destined to have a very great development. We allude to the driving of small fans or blowers. There are a great many places where it is now the practice to use a jet of steam or compressed air to move moderate amounts of air. Familiar examples are the steam jet blowers used under stationary boilers and for producing draft in small marine boilers, in locomotives, etc. It is well known that the ejector or steam jet blower is an inefficient apparatus for moving air, even when it is intelligently designed, which is very seldom the case. Its advantages are its extreme compactness and simplicity, there being no moving parts.

It is now proposed to substitute for such ejector blowers a small centrifugal fan driven by a miniature steam turbine mounted on the same shaft. The turbine is of exceedingly simple and cheap construction, being nothing but a single casting with its rim shaped into buckets of the Pelton style. The fan, of course, is or may be almost equally simple, and the whole outfit can be made and sold at a price so near that of the jet blower that it becomes merely a question as to the relative advantage of the two. Steam jet blowers are well known to be "steam eaters," and while the efficiency of a miniature, crudely-made steam turbine would doubtless be low compared with turbines of large size, it would, almost certainly, be enormously in advance of the ordinary steam jet blower.

PROGRESS IN THE WORK OF TURNING CHICAGO'S SEWAGE AWAY FROM LAKE MICHIGAN.

The work of preventing the pollution of Lake Michigan at Chicago, in order to protect that city's water supply, has been advanced another step by the award of contracts amounting to over $1,000,000 for another part of the intercepting sewer system, but it will be four or five years before this system is completed. This time estimate is based on the presumption of a steady continuance of the work, but experience with the construction of other parts of the system, and the delays due to labor troubles, litigation, etc., indicates that the pollution of the lake will not be finally stopped until a much more distant date.

When the great Main Drainage canal was first completed, and the water was turned into it (on Jan. 2, 1900) it was popularly supposed that the city would thenceforth have a pure supply of water, but this is very far from being the case, and very much yet remains to be done. It is undoubtedly true that an important improvement has been effected, as shown by statements from the Health Department quoted in our issue of Sept. 1, 1904, but nevertheless the Department for a long time has considered it necessary to report in the local papers the daily condition of the water from the various intakes. The

intercepting sewer system was described in our issue of May 28, 1903, and it may be of interest now to review the present situation. The drainage canal connects with the south branch of the Chicago river (which is in the form of a Y, with the main stem leading to the lake), and reverses the flow, so that the sewage and filth discharged into the main river and the South Branch now flow to the canal and the Mississippi River instead of into the lake. The North Branch remains practically stagnant, and at its junction with the main river there is a sharp line of demarcation between the black water of the former and the practically clear water of the latter. Since the completion of the canal extensive improvements have been made along the river to increase the capacity of flow; these include dredging the channel, straightening and bulkheading the banks, building by-passes, and removing the center piers of several swing bridges (which bridges have been replaced by bascule bridges).

But even with the canal completed and the river improved the lake is still polluted by sewers discharging along the shore, north and south of the mouth of the river. The sewage thus discharged may, under certain conditions of winds and currents, pollute the water which reaches the waterworks intakes. To prevent this, a system of intercepting sewers was planned; in both the north and south sections of the city there will be a main sewer approximately parallel with the shore and intercepting all sewers which now extend to the shore. The South Side system terminates at a pumping station on the lake front at 39th St., whence the sewage will be pumped through a 20-ft. tunnel running west under 39th St. to the river. In order to provide for the proper dilution of the sewage, and to give the required flow in the river and canal, water from the lake will also be pumped into the tunnel, as may be required. On the North Side there will be a similar line of intercepting sewers, leading to pumping station on the lake front at Lawrence Ave., whence a 16-ft. tunnel will be built under that avenue west to the north branch of the river. Lake water will also be pumped here, but will be taken from an intake shaft and crib in deep water by a tunnel of horseshoe section, 14 × 20 ft., 1,370 ft. long. The South Side system is now practically completed, and much of the heavier work was done by the city. On the North Side the Lawrence Ave. tunnel conduit was commenced a long while ago, but the contractor failed and the city proposed to undertake the work. This was opposed by certain interests, however, and work has been delayed by prolonged litigation, which ended in a decision by the court that the city must let the work by contract. The contracts already referred to as having recently been awarded cover the Lawrence Ave. tunnel, the lake tunnel with intake shaft and crib, and the pumping station.

But this is not all. Beyond the limit of the South Side intercepting sewer system is a low-lying district, which is to have a sewer system of its own, converging at a pumping station where the sewage will be elevated and discharged into the main intercepting sewer. Even with all these sewers and intercepting systems completed and in operation, the water supply will still be liable to pollution. On the north is the city of Evanston, and on the south is the Calumet district, the latter having the Calumet River, which discharges both sewage and industrial wastes into the lake. To deal with the Evanston sewage, a canal is to be built from the lake to the north branch of the Chicago River (Engineering News, June 8, 1905), and a system of intercepting sewers will discharge into this canal the sewage which is now discharged along the lake shore. This canal will have a capacity of 60,000 cu. ft. per minute, and it is proposed to build it as a ship canal, with dock fronts and wharves, so that it may be a commercial benefit to the city. For the Calumet district a canal will be built from the Calumet River to the main drainage canal, thus reversing the flow so that the sewage will flow to the canal and the Mississippi River instead of into the lake (Engineering News, Feb. 9 and June 8, 1905). At the present time, the main drainage canal is the only part of all this complicated and costly system which is completed and in operation.

One feature of the pollution still remains to be noted, and that is the accumulation of sewage and filth which lies upon the bed of the lake in front of the city as the result of years of sewage flow and the dumping of dirt dredged from the river. This is stirred up by the storms and is liable to cause pollution of the water at the intakes under certain conditions. It is doubtful, however, whether any work will be undertaken to deal with this phase of the problem. The main drainage canal and the improvements of the river have been executed by the Chicago Sanitary District, whose total expenditures to July, 1905, amounted to $46,581,454; the District will also build the Evanston and Calumet drainage canals. The intercepting sewers, and their pumping plants, etc., are built by the city (mainly under contract). The total cost of these present and future works for securing the purity of the water supply of Chicago may be summarized as follows, and it is to be noted that the cost given for the canal and the river improvements does not include administration cost or legal expenses:

Main drainage canal (right of way, $3,446,936; construction, $24,686,684)	$28,133,620
Chicago River improvements (right of way, $1,915,454; construction, $4,243,766)	6,159,210
Calumet drainage canal (right of way, $750,000; construction, $12,000,000)	12,750,000
Evanston drainage canal (right of way, $1,000,000; construction, $3,000,000)	4,000,000
Intercepting sewer system	4,750,000
Special sewer districts	750,000
Total	$56,542,830

Large as this sum is it includes no part of the large amounts spent in earlier years to extend the water intake tunnels beyond the reach of sewer, shore and harbor pollution. Allowing for these sums, and for the excess of costs over estimates, Chicago will have spent, say, a round $70,000,000 in separating its sewage from its water supply. It will still be drinking unpurified water, and it will still be sending its untreated but highly diluted sewage to the ocean by the long route of the drainage canal, Des Plaines, Illinois and Mississippi rivers. Could it have done better, either in point of cost or of sanitary protection of its own citizens and those of other municipalities? It would be presumptuous for us to attempt to answer so broad a question at the conclusion of this review of the cost of the drainage canal and allied works, particularly in view of the fact that numerous of the foremost hydraulic and sanitary engineers of the country have advised Chicago to do substantially what it has done. Moreover, both the pros and cons of the drainage canal have been discussed voluminously by numerous experts in the St. Louis suit against the drainage canal. Some day the U. S. Courts will have digested the evidence and then we may expect a decision on the relation of the drainage canal to the water supply of St. Louis. Sanitarily, Chicago has received vast benefits from the separation thus far made of its water supply and sewage. If it can gain proportionate benefit by continuing the expenditure in the interests of a pure water supply it should not stop short of at least $100,000,000.

LETTERS TO THE EDITOR.

Are Rivets Damaged by Overheating or "Burning"?

Sir: As a continuation of the recent discussion on imperfect rivets I should be pleased if you would invite a discussion on burnt rivets.

What are burnt rivets, and are they a frequent cause of failures? Should a rivet that is slightly pitted be condemned? What are the signs of a burnt rivet, first for a rivet not yet driven and second for a driven rivet? Is it possible to injure the metal of a *wrought iron* rivet by overheating in an ordinary portable furnace? Are the sparks emitted by the heated rivet over a sign of overheating? Should a rivet that has been reheated several times be condemned on that account? What are the principal points to be observed in the heating of field rivets? What are the more common and the most important faults in the heating of field rivets?

A Subscriber.

A Fast Tracklaying Record in South Africa.

Sir: The enclosed cutting from the Bulawayo "Chronicle" of to-day's date may be of interest. Five and a half miles of plate laying from 5 a. m. to 4.30 p. m., Sept. 29, is a very smart performance. I should be glad if you would add a note as to other records, if you have them, for the United States or elsewhere.

I am, yours faithfully,

C. [illegible]
M. Inst. C. E.; Assoc. M. Am. S[illegible] E., Resid[illegible] Engineer.

Resident Engineer's Office, The Beira & [illegible] Rhodesia Railways (Northern [illegible]tionaland [illegible]nsions).
Bulawayo, Sept. 30, 1905.

The clipping sent is as follows:

Livingstone, September 29th—The South Af[illegible] record for railway construction was broken to-day w[illegible] Messrs. Pauling and Co., Contractors for the Broke[illegible] Railway, completed 5½ miles of plate laying betw[illegible] a. m. and 4.30 p. m.
The rail head is now 168 miles from the Zam[illegible] Falls.

(To the best of our recollection the r[illegible]d for fast tracklaying was made in the fall of [illegible]97 on the construction of the Montana Cen[illegible] Ry. (now part of the Great Northern syste[illegible] from Minot, No. Dakota, to Great Falls, Mont[illegible] 625 miles of railway line were built during [illegible] single season by the contracting firm of Shepard, Winston & Co., the last rail being laid at Great Falls, Montana, on Nov. 19. We have not been able to find published figures as to the exact records then made; but our impression is that on one occasion between eleven and twelve miles of track were laid in a single day—that is to say, from the time work began in the morning until it stopped at night. We need hardly add that this feat was not accomplished by work on the 8-hour plan. We shall be glad to hear from any of our readers who can give us, for record, the actual best day's work on that piece of railway construction.

For our correspondent's information we may add that a record of 5½ miles of tracklaying per day would be accounted a decidedly "smart" performance even in the United States. We do not now recall any better record on this side of the water, except the work on the Montana Central, above mentioned.—Ed.)

The Value of a Railway Location that Shuts out a Competitor.

Sir: Observations made while locating railway lines and revising old locations lead me to believe that, apparently, quite a number of locating engineers do not fully appreciate the value of monopoly to their respective companies and as a consequence do not always occupy strategic points as fully as possible.

For instance, it frequently occurs that there are two possible lines through a country which differ only slightly either in cost of construction or capitalized value (the monopoly feature being neglected), one of which does not fully occupy the ground (that is, it is so located that a rival road could readily be built through the same valley or pass) while the other fully occupies the ground and would make it difficult, if not practically impossible, for a rival to build a parallel road. This applies frequently to even the shortest branches and spurs.

This seems to me to be an important consideration which I do not remember ever having seen mentioned in print except in Mr. Beahan's "Field Practice of Railway Location," where he says:

Always make future competition pay more for future advantages over the line now located than these advantages are worth,

And by the writer in a discussion of a paper on railway location before the American Society of Civil Engineers.

Another matter which it seems to me deserves greater attention than it sometimes appears to receive from some locating engineers is the practice of keeping one's mouth shut and not imparting information concerning the railway company's plans or possible plans. The importance of this policy of silence should also be brought prominently before every member of a locating party.

Respectfully, Walter Watson.

Salem, Va., Nov. 1, 1905.

(The point our correspondent raises is really a strong argument for State limitation of the construction of parallel and competing railways. Everywhere in England, and in this country in the States of Massachusetts, Texas and New York, no railway line can be constructed to parallel an existing road unless it can be shown to the State authorities that the existing road is incapable of furnishing all the transportation facilities that are needed for the public convenience. Speculative railway construction merely to divide traffic with an existing road, or blackmail it into an offer of purchase, is strictly forbidden.

There is a multitude of strong arguments in favor of this policy; and one important one, as shown by our correspondent, is that a country's railway system can then be located where pub[illegible]

convenience and economy of construction and operation dictate, and there is no need of wasting money in useless detours to prevent the construction of parallel competing lines.—Ed.)

The Case of John W. Hill: A Suspension of Judgment Requested.

Sir: Your attention has been called to the publication of the report of Messrs. Gillette and MacLennan and the editorial comment thereon in the issue of your paper of this date. In view of the fact, as we are firmly convinced, that this Report was published at this time, and largely gotten up for the purpose of affecting the present political contest and also the approaching trial of John W. Hill, lately Chief Engineer of the Bureau of Filtration of the City of Philadelphia, we ask you to make public, through your journal, this letter, in order that ourselves and the profession may know Mr. Hill's position, and the true reason why he has not had, up to this date, an early trial of his case.

Under our advice Mr. Hill has refrained from making any statements or published answers to the manifold things which have been said and published concerning him and his work, deeming it for his best interests that his case should be made known and his answer presented in the forum established by law for the trial of the questions involved in the accusations against him. We have persistently, under his strenuous requests, made application for an early trial of his case. The arrest was made in June, and this was followed by the summer vacation of the Courts, during which this case could not have been tried, and, therefore, early in September, application was made for a day to be fixed. We were told that the case would be set for the 18th of September. On the 18th of September last past we fondly hoped the case would be reached and tried, but, for reasons which were satisfactory to the District Attorney, it was postponed. We made application on the 2d of October to have the Court fix a day, but because it was so near the close of the term the Court declined to do so, remitting the question to his successor in the following month. Meanwaile the District Attorney gave us notice that the 17th of October had been set as the day for the trial. We made all preparation, gathering witnesses from a great distance and going to great expense, so as to be ready to try the case and dispose of it on that day. Again we were met by a postponement. On the application of the District Attorney and against our protest the Court refused to force the District Attorney to begin the trial, and among other things said that the case should not be tried prior to the election in November. There was no help for Mr. Hill or his counsel but to submit to the ruling of the Court. It was a matter from which no appeal could be taken, and so, protesting against the delay, we have sat quietly waiting for a new appointment for trial.

Meanwhile this Report of Messrs. Gillette and MacLennan is published with various comments, and a copy of it is sent to your paper for publication. In our judgment a casual examination of the Report itself, by an engineer, will furnish the basis for the refutation of all that it states by way of accusation. We have advised Mr. Hill to make no answer to this Report, however hard it may be for him to quietly submit to it, and we are of the opinion, most pronouncedly, that our place for answering is in a Court of Justice, where we will get fair play. With unabated and absolute and abiding confidence in the entire innocency of Mr. Hill we earnestly urge you, through your influential journal, to ask the brethren of his profession to suspend judgment until his case is tried and the truth disclosed, when there will be no difficulty in their joining with us in the recognition of his innocence.

We beg leave to call your attention to an error that has crept into the publication of this Report, in that it associates the name of Mr. William Barclay Parsons with Messrs. Gillette and MacLennan. In point of fact Mr. Parsons has not joined in this Report in any way and has not signed it.

Yours truly,

Geo. S. Graham,
Edw. W. Magill,
Joseph T. McCullen.

1420 Chestnut St., Philadelphia, Pa., Nov. 2, 1905.

(The members of Mr. Hill's profession will be more than pleased if it shall be established that Mr. Hill is innocent of the charges brought against him, and will be quite willing to suspend judgment until an impartial tribunal shall decide to what extent Mr. Hill was responsible for the conditions disclosed at Philadelphia.—Ed.).

Some Stories for Engineers.

Sir: Apropos of the "Proverbs for Engineers" published in your edition of Oct. 12, the writer has sometimes wondered while perusing the interesting but necessarily somewhat dry columns of Engineering News, whether it would be entirely beneath the dignity of that excellent journal to recount some of the less prosaic incidents and stories of engineers' lives—bits of humor which often only an engineer can appreciate, and amusing experiences of which almost any engineer can recall half a dozen or more.

There is the story—perhaps not new to some—of the well-meaning farmer who was asked by the chief of a railroad survey party to "take good care of the stakes" set in running a line across his land. When the surveyor reappeared a month later he was met by the cheerful announcement: "I took good care o' them stakes, I've got 'em all here in the wood shed!"

The mistakes of beginners are often amusing, especially beginners with a transit, who usually handle it as though it were about to explode. On one occasion a new and rather stupid youngster was trying to "give line" through a transit to a man with a plumb-bob. He first signaled one way, then the other, then was silent a long time and finally blurted out: "I can't see the string, its behind the hair!"

As showing that a college course does not always teach everything, a man fresh from college, and doubtless well up in calculus, was somewhat hurt by being sent out as his first practical piece of work to measure a lot of lumber with a foot-rule. After working all day he came back and announced that the pile contained 480 ft. "beam." Somewhat puzzled the chief engineer questioned him and discovered that college had failed to impress him with the fact that B. M. stood for board measure.

A cross-grained old surveyor was being examined by a lawyer as to a certain measurement which he had given as two feet. "Are you sure," said the lawyer, "that it was not two feet, one inch?" "Yes, sir." Are you sure that it was not one foot, eleven inches?" "Yes, sir." "Well, now, Mr. Blank, please tell the jury how you know that it was just two feet." "Well," he drawled, "I thought some durned fool would ask me that, so I measured it."

Descriptions of property in old deeds are sometimes more interesting than useful. Some years ago the writer had occasion to look up the deeds for a part of the right-of-way of the old Mad River & Lake Erie R. R., said to be the first road built west of the Alleghanies. One deed, dated about 1857, contained a description somewhat as follows: "Beginning at a haystack in the south side of said tract, thence proceeding in a northerly direction to a tree with a crow's nest in it," etc. At last accounts neither the nest nor the haystack had been located.

Of a sort to be appreciated by engineers and others is the tale of the old man who rushed breathlessly down the street holding his hands spread apart and shouting, "Don't joggle me, I have the measurement for a door!" Doubtless there are many older in the business than the writer who could recall other and better stories.

I. S. E.

(We are always glad to welcome contributions which furnish sauce and seasoning for our pages. Our only requirement is that it shall be such excellent sauce as to be worth the space it takes. There are of course many stories which are delightful enough when related in a vivacious manner, but which sound flat to the reader when put into type, and this with other considerations compels judicious selection on the part of the editors.—Ed.)

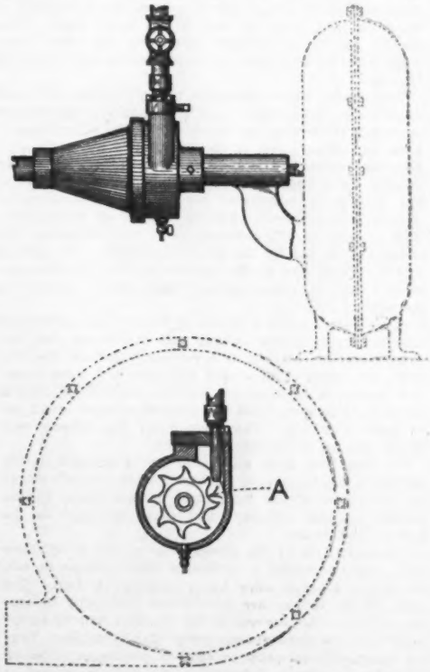
Notes and Queries.

B. S. R., Guthrie, Oklahoma, asks what legal liability a City Engineer or County Surveyor incurs in case he makes an error in locating building lines or property lines in a city; also what court decisions exist as to the legal liability of an engineer or surveyor who has to locate a line where all original monuments and block and lot stakes are gone and the correction is disputed?

What is a proper form for a "Certificate of Survey" and what should it contain?

A FAN BLOWER DRIVEN BY A STEAM TURBINE.

The accompanying drawings show a portable centrifugal blower or fan driven by a miniature steam turbine, which has recently been put on the market by the Star Drilling Machine Co., of Akron, O. This blower was designed particularly for operating smiths' forges in connection with well drilling machines, but it is suitable for any place where air blast is required and where steam or compressed air are available for power. As will be seen, the bucket wheel A is attached direct to the fan shaft, and is inclosed in a casing which provides for the jet pipe and the exhaust. The whole construction is exceedingly simple, and can be understood from the drawing. A size 3 blower, mounted on a wood base complete, with 2-in. jet pipe, costs f.o.b. Akron, O., only $15; a No. 1 outfit costs $11.



A Steam Turbine-Operated Centrifugal Blower.

THE SANITARY CONDITION OF THE NEW YORK RAPID TRANSIT SUBWAY.

An official report has been made to the New York Rapid Transit Commission respecting the sanitary condition of the subway. The author of the report is Dr. Geo. A. Soper, M. Am. Soc. C. E., who was engaged by the Commission several months ago to make an exhaustive examination of the subway in view of the numerous published complaints concerning the subway air.

The report, which was presented on Oct. 19, is a preliminary one, as Dr. Soper's study of the subway is still in progress. We print the report as follows:

SCOPE OF THE INVESTIGATION.

The principal questions investigated have been the temperature, humidity, odor, bacteria and dust of the air of the subway. In studying each of these subjects the plan has been to obtain an accurate knowledge of, First, the conditions which actually exist; Second, the causes of these conditions; Third, what, if any, is the remedy required.

No attempt has been made to devise a comprehensive system of ventilation or cooling, this being understood to be beyond the scope of the service desired of me. My single expression of opinion in this direction has been that considerable benefit would result if provision could be made for larger and more direct openings from some of the subway stations to the outside air. In the present report this statement is repeated and supplemented by the opinion that the ultimate solution of the problem of a cool subway must lie in mechanical improvements which will prevent the production of the heat through a more economical employment of the power used to operate the road.

PRINCIPAL RESULTS OF THE INVESTIGATION.

Regarded as a whole, the results so far obtained contain little cause for alarm concerning the sanitary condition of the air of the subway. During the period of my observations the air has been renewed with sufficient frequency to assure an ample supply of oxygen and prevent the detection of unpleasant odors due to the large number of people who have been present in the subway. Odors from other causes have, however, occurred. The principal objection to the air has been its high temperature. The sanitary significance of the presence of black dust and of the bacteria which are contained in the air, however, still remains to be settled.

Heat and humidity.—Throughout the period of this investigation, the subway has been decidedly warmer than the outside air. The average temperature for the day-time for the three months was, for the subway, 79.8 F., and for the air in the streets, 72.8 F.; difference, 7 F. The highest temperature observed in the subway was 90.6 F.

The hottest week was that of Aug. 4-10, inclusive. The average daily temperature for the subway during this time was 83.1 F. For the outside air it was 73.2 F.;

the difference being 9.9 F. The maximum temperature observed in the subway this week was 88.5 F.; in the streets 88.2 F.

The air of the subway has generally been less humid than the air of the streets. The average humidity for the three months was 56.2%. The hottest week was also the most humid in the subway, the percentage of relative humidity having been for the week of Aug. 4-10, 75.2%.

The high temperature of the subway is due chiefly to the amount of power which, in one way or another, is converted into heat in operating the road. Most of it comes from the motors and friction brakes on the cars. Theoretically, it represents wasted energy. No remedy seems ready-to-hand for this trouble. It is a new difficulty in the operation of subways and is attributable to the large amount of electric power used on the road. The most hopeful direction to seek immediate relief from the heat lies, in my judgment, in the alteration of some of the stations so that greater benefit will result from the combined ventilating effect produced by the movement of the trains and the breezes of the streets. Had it not been for the flushing action which was produced already in this way, the subway would undoubtedly have been much warmer last summer.

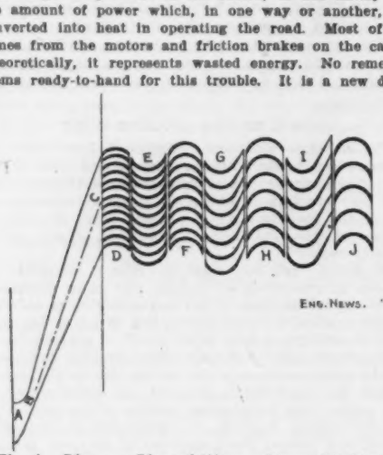


Fig. 1. Diagram Plan of Warren Steam Turbine.

It would seem that the ultimate solution of the difficulty of overheating must lie in mechanical improvements which will prevent the production of so much heat through the great loss of energy which now occurs when the trains are stopped and started. A subject which seems worthy of consideration in connection is the idea of regenerative control. Again, a lower speed from station to station would prevent the production of so much heat from the motors and brake shoes. This should be possible without sacrificing the actual running time, by improved means of loading and unloading the cars.

Ventilation.—There has been, on an average, far more fresh air in the subway than is necessary to satisfy the standards established by sanitary authorities for theaters, halls and other places of assembly. The air in the cars has been somewhat less satisfactory, depending on the amount of crowding. The test employed to measure the amount of ventilation has been the estimation of carbon dioxide present by the method of Pettenkofer. The average of 721 analyses gave, for the air of the subway, 4.58, and for the air of the streets, 3.45 parts of carbon dioxide per 10,000 volumes of air; the difference being 1.13. The largest amount found on any occasion in the subway was 7.81.

There was so slight a difference between the amount of oxygen present in the subway and outside air that the employment of this test as a routine procedure was discontinued after about eighty analyses had been made. The difference between the smallest amount of oxygen found in the subway and the greatest amount found out of doors was .7%. The average for the subway was 20.6%, and for the outside air 20.71%.

The frequency with which the air is changed in the subway is attributable, in my view, to the currents set up by the action of the trains and breezes above ground coming through stairways and other openings to the stations and streets.

Odors.—The air of the subway has at nearly all times and places possessed a noticeable odor. There is not, in reality, a single odor but a number of them. The odors of the subway are attributable principally to conditions due to the newness of the structure and its equipment and are largely susceptible of elimination. They are traceable principally to volatile substances given off by paints, cements, lubricating oil, hot boxes and a chemical deodorant used in the toilet rooms. The presence in the air of black dust is also accountable for a part of what is generally taken to be odor.

Dust.—The amount and character of the black dust in the subway is a matter of considerable importance. Chemical analysis of this dust shows that it contains 62.78% of metallic iron. Microscopic analysis shows that the particles range from fragments which can almost be seen with the naked eye to pieces less than 1/25,000 of an inch in diameter. Most of this pulverized iron is due to the grinding up of brake shoes, the daily loss in weight of which is surprisingly large. Dust of the same kind has made at least one other subway dark and grimy in appearance. In another case, the gradual accumulation of iron dust is said to have seriously interfered with the insulation of the electric current.

It is important, in my view, to take notice of the presence of this iron dust both because of the possibility of its affecting the health of persons who must continually breathe it and on account of the black stain which it imparts to the light-colored portions of the subway structure, cars, booths and other furniture, and the persons of the employees and passengers.

Because of the presence of about 1% of oil which the dust contains, it gains secure lodgment upon all surfaces, and being of a black color, forms an unsightly smudge which is difficult to remove. An amount of this dust which is too small to be weighed with accuracy is capable of producing a black mark upon white linen which can be seen at a distance of twenty feet. If this linen is moistened with perspiration or water, a yellow stain is produced. Straw hats and the light-colored garments worn by passengers of both sexes in summer are therefore liable to be soiled by coming in contact with even small accumulations of the dust. The actual weight of black dust in a cubic foot of the atmosphere at any time is slight. It would undoubtedly be greater if the ventilation of the subway was any less effective. Mainly because of the possibility that it may be injurious to health when breathed continually through long periods of time, the subject of dust and its prevention is now receiving my special attention. It would appear that in order to prevent the formation of the dust, a less heavy use of the friction brake would be required.

Bacteria.—There have generally been fewer bacteria in the air of the subway than in the air of the streets, but occasionally there have been more. A study of the results of 2,600 tests shows that the average number of bacteria which were deposited per minute upon a square foot of surface and were subsequently capable of growing at the temperature of the human body was, for the subway, 750, and for the air of the streets 1,200. Although it is not improbable that the bacteria in the subway belong, for the most part, to the same species as those above ground, the study of this subject has not yet reached a point which will justify a positive statement concerning its sanitary significance.

Other sanitary observations.—A number of sanitary observations of less importance than the foregoing have been made. As a result of these, the three following suggestions are respectfully submitted as especially worthy of our consideration at the present time:

1. That the ballast of the roadbed which has become saturated with oil from the machinery of the cars and has accumulated a quantity of small refuse from the stations and passengers should be renewed at the stations, or better, replaced with a smooth concrete surface which can easily be cleaned. In order to protect the roadbed against oil in the future, the use of large drip pans beneath the cars and more frequent inspections are suggested.

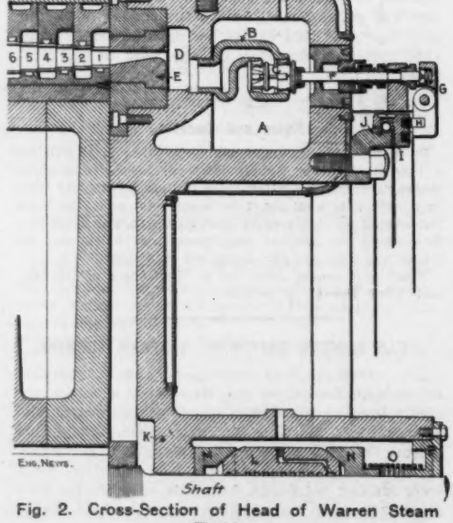


Fig. 2. Cross-Section of Head of Warren Steam Turbine.

2. That the stations be cleaned and cared for in a more systematic and thorough manner. The suggestions made by the Board of Health with respect to this matter are strongly recommended for adoption, except as to the use of disinfectants; with strict cleanliness, these should not, in my judgment, be necessary. A copy of the Board of Health suggestions is herewith appended.

3. That the toilet rooms be equipped with suitable means of ventilation and that they be kept in a more strictly sanitary condition.

TWO NEW STEAM TURBINES.

The great success which has attended the introduction of the steam turbine, for both large and small units and for various applications of power, has naturally resulted in numerous designs of steam turbines, all of which have certain special features and for which certain advantages are claimed. Two of these new designs are described and illustrated in this article, and both are of the "velocity" type. In a paper read before the Western Society of Engineers* by Prof. Storm Bull, of the University of Wisconsin, it was pointed out that these machines are sometimes classed as impulse and reaction turbines, although, in fact, all turbine wheels are reaction wheels. A better classification would be (1) "velocity turbines," in which the expansion takes place only in the nozzle and the stationary guides, and (2) "pressure turbines," in which the expansion is continuous through both the rotating wheels and the stationary guides.

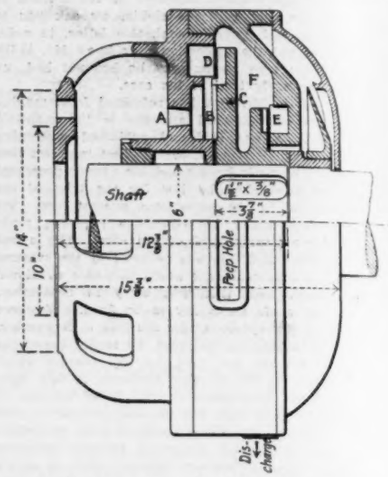


Fig. 3. Thrust-Bearing for Steam Turbines.

THE WARREN STEAM TURBINE.—This machine, as above noted, is of the velocity type, with alternate guide wheels and turbine wheels, the steam expanding only in the nozzle and the guide wheels. It is designed on the principle of expanding steam in a diverging nozzle, thus transforming the energy due to pressure into high velocity, and then using the velocity in different stages. The general arrangement of the turbine is shown by the diagram plan in Fig. 1. Here A is the nozzle inlet, B the throat and C the mouth, at which the steam is expanded to a given velocity. The steam strikes the blades of the wheel D, and is discharged into the fixed guides E, where it is again expanded to maintain the average velocity established at C. It then passes in succession through the several stages (turbine wheels, F, H, and J; and guides G and I) until the total velocity of the steam has been used. The number of wheels and the ratio of expansion in the nozzle are determined by the steam pressure, the vacuum and the degree of superheat employed.

In Fig. 2 is a partial section at the head of the machine: A is the annular steam chest containing a number of valve cases, B, and valves, C, arranged in a circle. Each valve case opens into a chamber, D, from which two nozzles run to the face of the wheel. These nozzles are not perpendicular to the wheel, as would appear from the section, but are at an angle with it, as shown by the plan in Fig. 1. At 1, 3 and 5 are the turbine wheels, while at 2, 4 and 6 are the fixed guide wheels. The valve stem F is given a recip-

*Journal of the Western Society of Engineers, August, 1905. Abstract in Eng. News of June 15, 1905, p. 619.

rocating motion by the bell-crank G, which is operated by cams H in the face of the cam wheel I. This wheel runs on the ring or race of balls J, and is geared to a pinion on a shaft driven from the governor. The number of cams is equal to the number of valves, and the valves are opened and closed in succession according to the load; the cams are so arranged that not more than one valve is operated at a time, and the number of valves open is only that which is required to deliver sufficient steam to carry the load. By this method the pocket, D, is always operating at full pressure, or at its maximum efficiency, and the

FIG. 4. WARREN STEAM TURBINE AND ELECTRIC GENERATOR FOR THE U. S. NAVY YARD, AT BOSTON, MASS.

builders state that, "with this method of construction, the turbine has practically no part-load efficiency, as the section of nozzle buckets and guides that are doing the work are working at the maximum pressure for each stage, this pressure being never changed by any change of load."

The section in Fig. 2 also shows the method of preventing leakage of steam along the shaft. At K is the cast iron casing, and L is a bronze sleeve held against the ground ring M by the backing ring N and spring O, held up by the cap P. Water is admitted to the bronze sleeve, and drawn back through it by suction, being discharged at the base into the condenser pipe. The end thrust is taken up by the thrust bearing shown in Fig. 3, in which A is a pipe opening in the cast iron case through which oil is pumped into the chamber. A given pressure in the chamber will tend to force disc C away from seat D and against seat E. But when disc C moves away from seat D the passage at seat E is partly closed, and the passage at seat D given a larger opening; then the pressure in chamber F will become the same as in chamber B, and cause the disc to float between the two seats, so that A will never actually come in contact with either one, no matter what the end thrust may be, providing it is within the range for which the bearing is built. The end thrust bearing in Fig. 3 will automatically take care of pressures between 1,600 and 25,000 lbs. In the double-flow turbines, however, there is no end thrust, as the steam is admitted at both ends and discharged at the middle through the base. An oil pump maintains a circulation of oil (cooled in a water chamber) through the bearings.

The following advantages are claimed for this new type of turbine: 1, high steam economy under varying loads; 2, small number of parts; 3, small weight and floor space per kilowatt; 4, simplicity of operation; and 5, little liability of getting out of order. They will be built in various sizes of 100 to 3,000 KW., and with speeds of 3,600 to 600 revolutions per minute. A 750-KW. generating unit has been built for the Consolidated Lighting Co., of Montpelier, Vt., while Fig. 4 shows one of two turbo-generator units of 1,000 KW. built for the U. S. navy yard at Boston, Mass. It is also intended to apply the turbine to centrifugal pump work. This steam turbine is the invention of Mr. E. C. Crocker, and is manufactured by the Warren Electric Mfg. Co., of Sandusky, O.

THE HAMILTON-HOLZWARTH STEAM TURBINE.—This turbine is also of the velocity type, consisting of a number of stages, each of which comprises a stationary guide ring and a running wheel, both fitted with blades or vanes in the usual way. In each stationary ring the steam is expanded down to a certain pressure, and then drives the adjacent running wheel by the velocity produced by this expansion. A special feature of this design, which is illustrated in the section Fig. 5, is that machines of over 750 KW. are divided into two parts, for high and low pressure, making a compound machine. In the section, the stationary rings and the rotating wheels are marked S and R respectively. The section is only diagrammatic, however, and in practice the high and low pressure parts are much farther apart, while each has its own shaft, the ends of the shafts being connected by a flexible coupling. The steam passes first through a separator placed below the bed plate, then through the main inlet valve and a regulating valve, and thence to an annular chamber in the head of the high pressure turbine, from which it passes through a circular slot to the first stationary ring. After leaving the exhaust end of the high pressure turbine, the steam is led through receiver pipes to the head of the low-pressure turbine, through which it passes as before, and finally goes to the condenser. The low-pressure turbine, however, can be supplied with live steam through a small auxiliary pipe, this being for use in case of overload. This admission of live steam does not cause back pressure on the high-pressure turbine, but is said to act as an injector, drawing the low-pressure steam through the first stationary ring of the low-pressure turbine.

The stationary rings or discs are of cast iron, and extend nearly to the main shaft, so as to have a minimum clearance through which steam can leak. The rings are fitted to grooves in the casing, and have in the rim a groove to receive the drop-forged steel blades, milled to shape; after being riveted in place the blades and discs are ground on the edge, and a steel ring is then shrunk over the periphery. Each running wheel has a cast steel spider or hub, with two steel discs riveted to it, and the blades are riveted between the rims of these discs, which are flanged outward. The blades are milled to shape on both sides of the wheel, and on the outer edge of the wheel is fitted a thin steel band. Each wheel is carefully tested in a balancing machine before being fitted to the shaft. In the Warren turbine, above described, special claims are made for the avoidance of all throttling of the steam; but in the Hamilton machine the steam regulation is effected by one large throttle valve, and the makers state their reason for using this arrangement as follows:

> The throttling of steam has not the same bad influence for steam turbines as it has on reciprocating engines. In these engines we use only the static pressure of the steam, and it is not economical to throttle the steam. In steam turbines we do not use the static pressure but convert the whole potential energy into kinetic energy. If we throttle the steam we do not take off any fraction of its energy, we only convert some part of its potential energy into kinetic energy. The static pressure is reduced, but the velocity of the steam is higher. The amount of energy in the steam before the throttle valve is the same as behind the throttle valve, and if the steam is wet before passing through the throttle valve, the water is re-evaporated by throttling. For these reasons, and to avoid the complication of several nozzles and their exact regulation, we use one large, carefully designed throttle valve.

The regulating valve is a double-beat poppet valve, actuated by a regulating mechanism instead of directly from the governor, and this mechanism can be adjusted in order to change the speed of the turbine while running, which may be necessary to put it in parallel with another prime mover.

The design of this steam turbine was worked out by Mr. Hans Holzwarth, and the machines are built by the Hooven, Owens, Rentschler Co., of Hamilton, O. The first of these machines was a turbine of 1,500 HP., exhibited at the St. Louis Exhibition. This ran at 1,500 revolutions per minute, and was directly connected to a Bullock alternating current generator of 1,000 KW., 6,600 volts.

AIR-BRAKES IN FREIGHT TRAIN SERVICE.

Eight years ago, on Jan. 1, 1898, a Federal law went into effect forbidding the running of railway trains in interstate traffic without sufficient air-braked cars to control the train speed "without requiring brakemen to use the common hand-brake." On Sept. 1, 1903, an amendatory act went into effect, requiring every train to have at least 50% of its cars equipped with air-brakes in operative condition, and authorizing the Interstate Commerce Commission to issue orders increasing the required percentage from time to time.

A hearing was held by the Commission at Washington on Nov. 2, relative to an increase in the required percentage to 75%, this increase to become mandatory on Jan. 1, 1906.

The proposed increase was opposed by several of the leading railway companies; and the testimony of their representatives contained such interesting matter respecting the existing traffic conditions, and experience in the use of air-brakes that we present a full abstract as follows:

G. W. CREIGHTON, General Superintendent, Pennsylvania R. R. Division, P. R. R.—The Pennsylvania railroad has at the present time and will continue to have during the coming winter an unprecedented call for freight cars to meet the extraordinary demand on the part of the shipping public. To fill this demand we must use all our available cars. Any increase in the minimum

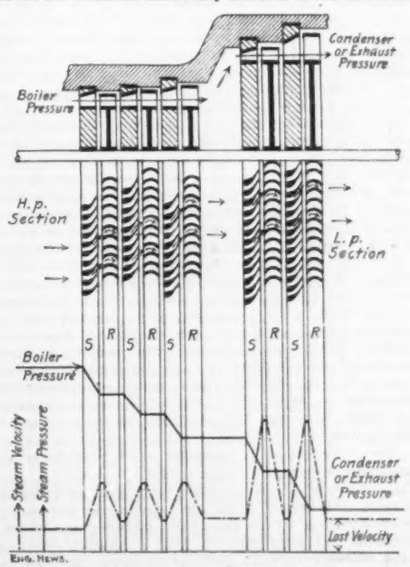


Fig. 5. Diagram Section of Hamilton Steam Turbine.

requirement for air brake cars would result in serious inconvenience to the railroads and to the public. The railroads are trying for their own advantage to equip all the cars they can with air brakes, but are held back by the pressure of business, the difficulty of getting cars built and by inadequate yard facilities. It was most difficult in 1903, with 83% of the cars equipped to meet the 50% requirement and it would be much harder now with an equipment of 90% to meet a 75% requirement.

Average must be clearly distinguished from minimum. It is not difficult to keep up to an average of 75% on all trains and as a fact the Pennsylvania Railroad has done

so for the last six months. But in spite of their efforts the railroad was frequently compelled to ru ntrains with less than 75%. I submit the following figures for August to show that a large percentage of our trains had to be run with a percentage of 75% and under:

Trains run, 12,856; cars, 476,742; cars with air brakes in use, 328,805; percentage, 70%.

Trains with:					Air brake cars.
More than	50%	and	less than	55%	4.2%
55	"	"	"	60	1.7
60	"	"	"	65	3.6
65	"	"	"	70	5.4
70	"	"	"	75	5.4
75	"	"	"	80	10.2
80	"	"	"	90	19.9
90	"	"	"	100	22.5
of 100	"	"	"	..	28.1
					100.0%

From the nature of the use to which the cars are put, some groups of cars have a lower percentage than others—e. g., the coke cars have a low percentage of equipment, and likewise the anthracite cars on account of the old-fashioned low coal breakers. The bituminous territory on account of new breakers, has a high percentage. It would be impossible to reach a 75% minimum on the coke and hard coal lines. There are 1,800 coke cars hauled daily, and of these 1,200 are not equipped with air brakes and cannot be for a long time. We are substituting new cars for the old ones as fast as possible, but of course this takes time. If this ruling is passed it will tie up our traffic completely on our coke and coal lines, and through them the iron and steel industry will be affected and the entire business interests of the country subjected to serious delay.

With the new cars being brought in we expect about Jan. 1, 1907, to have all our cars equipped with air brakes, but even then it would be hard, on account of the presence of foreign cars and the difficulty of keeping all cars up to operating efficiency, to reach any high minimum.

B. M. CRAWFORD, General Superintendent of Motive Power, Pennsylvania Lines West of Pittsburg.—The condition of the lines west of Pittsburg is much the same as on those east. In August we ran 2,192 freight trains, of which 21.17% had between 50% and 59% air, and 17% had between 60% and 69%; 37% of cars carried by these lines are foreign cars, some of which are more thoroughly equipped than our own, some less. All Pennsylvania cars will be equipped with air brakes by Jan. 1, 1907, but we could not live up to a 100% minimum.

The average life of a freight car is 16 years, equipping with air brakes costs between $50 and $60 and takes one day. The difficulty is to remove the car from active service and get it to the shops.

A. W. GIBBS, General Superintendent of Motive Power, P. R. R.—The Pennsylvania lines east and west of Pittsburg are cooperating in equipping cars suitable for equipment with air brakes. When a car is not fit to be equipped with air brakes it is removed from service and broken up. At one time in January, 1905, as many as 400 cars were broken up to increase the percentage of equipped cars. These cars have all been replaced. Orders for 16,000 cars have been placed and these are expected by the fall of next year.

When cross-examined, Mr. Gibbs stated that there was less risk of accident in a 100% train than in one of lower percentage. With much more air hose, more accidents to air hose are bound to occur, but these are getting less and less frequent since the railways began to comply with the 50% requirement. The operation of unequipped cars with equipped ones causes many breakdowns and it is to the interest of the railways to have all cars equipped.

F. H. CLARK, General Superintendent of Motive Power, Chicago, Burlington & Quincy.—On account of general condition of business it is hard to keep up to our stated average of 83%. Our yards are badly congested and any immediate increase would give trouble on account of pressure of business conditions. Our unequipped small cars were built 18 or 20 years ago and are of such small capacity that they are not worth repairing and equipping. Only 1,800 are fit to equip; of the others we are destroying 2,200 a year and replacing them as far as possible. We have large orders placed for new cars, but on account of the congested condition of the car trade we cannot get them before January, 1907.

In order to illustrate the effort being made by railroads to equip their cars, I would state that a rule was passed on June 1, 1905, by the Master Car Builders' Association, providing that after Sept. 1, 1907, a railroad receiving a non-equipped car shall hold the delivering company responsible, shall repair it themselves and send the bill to the delivering company, not to the owning company. The effect of this rule is that all cars must be equipped with air brakes by that date. If an order were made effective at once many cars would have to be taken out of service and the interests of the shippers would be seriously injured as it would be impossible to move traffic.

E. FITZGERALD, General Superintendent, Baltimore & Ohio.—We carry probably a greater proportion of foreign cars than any other line, on account of the coal fields in our territory. We have 30,000 foreign cars on our lines, and 20,000 of our cars on foreign lines. For this reason we find classification of cars for different locations particularly difficult, particularly as we must endeavor to place all the equipped cars towards the front of the trains. Our yards are small and this classification work is proportionally difficult. We have the greatest difficulty in complying even with the 50% requirement and this difficulty would be overwhelmingly increased by a 75% order. As it is we are now threatened with suits by coal shippers. We are doing what we can to replace cars, and have ordered 10,000 cars, but cannot get them till late in 1906. We buy no cars without air brakes and make no heavy repairs without equipping with air brakes, but to suddenly remove 10,000 cars from service would paralyse us.

There is little advantage in equipping an old car with air brakes so far as safety is concerned, as when an old and weak car gets in front of a train it is very dangerous. There are some grades on the B. & O. down which it is unsafe to run a train without emergency hand brakes. There is one 2½% grade in West Virginia, 17 miles long, where even slight defect would cause runaway and here men have to be ready to apply hand brakes when going down hill.

N. D. MAHER, General Manager, Norfolk & Western.—No difficulty is experienced in keeping up to the minimum requirement of 50% on main lines and it is probable that we could submit to an increase within a year, but on the branch lines the condition is serious. On account of light bridges they cannot stand the heavy standard cars, and on these branches we must use the old-fashioned light cars which are mostly non-air. The work of replacing these bridges is steadily going on and in a year we hope to have the entire equipment of bridges changed. We have expended $600,000 on this work and it will take $700,000 more. Of our non-air cars, we have equipped some 400 a year, and of the 6,000 now remaining, we expect to equip the 1,200 that are fit for it. The rest will be destroyed.

L. G. PARISH, speaking in behalf of the Lake Shore & Michigan Central R. R., dwelt specially on the order of the Master Car Builders' Association referred to by Mr. Clark. He said that he believed the railways would be willing to see a law passed by Congress requiring complete equipment by September 1, 1907. As for his own lines they could obey an order for higher percentage on main lines, but not on branch lines owing to light bridges. The Lake Shore is now purchasing 25,000 new cars which will be delivered in a short time.

R. E. SMITH, General Superintendent of Motive Power, Atlantic Coast Line.—We have no difficulty operating main lines with 50% equipment, but on local lines a train will start out from a terminal with 50% and have to pick up non-air cars at way-stations, which compels it to lay over cars at times for 24 hours.

J. N. SEALE, General Superintendent of Transportation, Southern Ry.—The Southern would be more affected than any railway in the country, for our system is made up of many small lines all greatly impoverished, and the equipment is old and out of date. The yard facilities are very inadequate, but eighteen months hence we will have as fine yard facilities as any road in the country. The Southern could live up to the proposed requirement by Jan. 1, 1907, but not sooner.

The demand for cars is heavier than ever before and there is danger of a car famine. The shippers are growing very restive and the position of the Southern is made much worse by the law in Virginia, North and South Carolina, which permit shippers to exact payment of $2.00 per car, when they ask for cars and cannot get them. Several thousand dollars of these "fines" are paid every year by us.

C. PETER CLARK, General Manager, Buffalo & Susquehanna, said that the special difficulty of his road is that on account of changing grades, trains have to be made up 13 times in course of trip from Buffalo to Pittsburg. Since the road has many heavy grades it is a rule for employees to keep hand brakes locked on grades and make engineers haul trains down hill, the air being used only for emergency.

E. E. CLARK, head of the Railway Conductors' Order.—From my knowledge of the employees' feelings I can say that they believe that perfection can only be reached when the railroads are required to have all their cars equipped and in use. The employees are willing to overlook unavoidable failure to keep up the exact percentage of 100, but they demand its general enforcement.

Figures show that the railroads have used an average of nearly 90% of air braked cars during the last six months; the Pennsylvania has used 76%. Previously in answering arguments of railways, I stated that the railways would make such savings in operating expenses on account of installing air brakes that they would be able to pay for the installation. This is the case; the Pennsylvania, for example, has reduced its force of brakemen in the proportion of three to two on 100% trains. Of course this reduction increases danger for three men can much better attend to signals and flagging than two, but the railroads have been able to recoup their expense by this policy of retrenchment. The principal reason that the railroads resist a 100% requirement is that they have old cars not fit to equip with air brakes and they wish to get full use out of them.

The employees are unanimous in their opinion that the use of the power brake is necessary to safety. I am willing therefore to accept in their name an [illegible] by the commission that on and after July 1, 1907, [illegible] of all cars used by railroads shall be equipped [illegible] perated with air brakes. No car can be unused but [illegible] must be connected and in use. What is wanted is a [illegible] settlement and not a series of hearings over each [illegible] ased increase in the minimum.

At the conclusion of the hearing the commi[illegible] stated that decision would either be rendered on the [illegible] vidence submitted or a new hearing would be held.

A WATER POWER ELECTRIC PLANT [illegible] levelop 100,000 HP. has been placed under construction at McCalls Ferry, Pa., on the Susquehanna River. [illegible] plant will cost in the neighborhood of $10,000,000. [illegible] will comprise a masonry dam some 30 to 40 ft. high [illegible] containing some 350,000 cu. yds. of masonry. [illegible] dam and power generating plant will be at McCalls [illegible] erry, a small village on the west bank of the river [illegible] at 15 miles directly south of Lancaster, and within a [illegible] dius of 60 miles are Philadelphia, Wilmington, Baltimo[illegible] Harrisburg, Reading and a dozen or more importan[illegible] Pennsylvania and Maryland cities of smaller populatio[illegible] The plant will be built by the McCalls Ferry Power [illegible] of New York city. Mr. Cary T. Hutchinson, M. A[illegible] Soc. M. E., New York city, is Chief Engineer, and Mr. Hugh L. Cooper, M. Am. Soc. C. E., is Manager of Construction and Hydraulic Engineer.

IMMENSE STEAM TURBINES are reported to be in process of building in the shops of two American manufacturers. The General Electric Co., of Schenectady, N. Y., has on order six Curtis steam turbine generating units each of 8,000 KW., four of which are for the Chicago Edison Co. and two for the New York Edison Co. The makers state that each of these machines will be capable of developing 18,000 HP., which means that they will have about 70% overload capacity. It may be remembered that both the New York Edison Co. and the Chicago Edison Co. have Curtis turbines of 5,000 KW. size in operation, the latter company having now in service a station designed especially for these machines, in which station the first 5,000 KW. steam turbine was installed and operated.

The Allis-Chalmers Co., of Milwaukee, Wis., has just shipped to the Brooklyn Rapid Transit Co., of Brooklyn, N. Y., a 9,000 HP. horizontal steam turbine for that company's new Williamsburg station. The turbine is of the multiple-expansion parallel-flow type, or "Parsons type," and will run at 750 r. p. m. It is to be direct-coupled to a Bullock alternating current generator built at the Cincinnati works of the Allis-Chalmers Co. The complete unit measures about 47 ft. in length, 13 ft. 3 ins. in width and 11 ft. 6 ins. in height above the engine-room floor. The makers say in regard to the construction of the turbine:

A noteworthy feature in the construction is the blading; the blades are made of a special alloy and of such form and dimensions as will secure the highest economy. The individual blades are mounted in groups, each group forming one-half of a circular row. The inner ends of the blades are swaged, firmly secured in accurately spaced slots in foundation rings and riveted in slots in their respective channel shaped shrouds. The blade rings are secured by special calking strips in accurately machined grooves in the cylinder and rotor, thus absolutely insuring against throwing out due to contrifugal force. The channel shaped shroud secures the blades in a substantial manner at the proper angle and spacing and eliminates the danger of stripping, permitting the turbine to be safely operated with a minimum radial clearance. The design of blading does away with hand-work. The machine construction insures great strength, perfect alinement, and uniformity in the spacing of the blades.

The lubricating arrangement is free from complications, complete and efficient. It is equipped with a direct acting steam pump for use on starting up the turbine. The turbine and generator rotors are direct-connected by a flexible coupling, each being carried in two bearings of the ball and socket type.

A CONCRETE RESERVOIR 300 ft. in diameter, with a depth of 15 ft. at the side and 25 ft. at the middle, is being built at Bloomington, Ill. It is of reinforced concrete with a toe on the outside of the wall, and a circular cut-off wall built in a trench under the bottom at about 11 ft. from the side wall. The excavation is mainly in gravel, underlaid by clay, and the material was excavated by a Page scraper suspended from a boom and operated from a tower or platform (Engineering News, March 2, 1905). The work is being done by the Crescent Stone Co., of Peoria, and the plans were prepared by Mr. Dabney H. Maury, M. Am. Soc. C. E., Consulting Engineer, of Peoria, Ill.

MUNICIPAL STREET RAILWAY OPERATION at Liverpool, England, has proved a decided success. The following figures of results are given by U. S. Consul Griffiths, of Liverpool, in a recent official report:

In 1897, the last year of private tramway ownership in Liverpool, 38,409,084 passengers were carried, and the gross receipts were $1,413,035. In 1904 there was an aggregate of 116,642,563 passengers carried, and the receipts were $2,628,531. Much of the increase is to be attributed to the electrification of the tramway system and to the natural growth of population, but much is also due to economical, judicious, and wise management.

Since the city has operated the tramway lines the fares have been reduced nearly one-half; the length of the stage (the distance for which a single fare is charged) has been increased three-fold, and the average speed has been advanced from 5½ miles to 8 miles an hour. The tramway employees were paid about $194,400 more last year than they would have received under the scale of wages which prevailed under private ownership, and in addition proper provision has been made for their recreation and amusement and in case of sickness. An old-age pension is now being considered.

Under municipal ownership, in the brief period of seven years, notwithstanding the reduction of fares, the increase in mileage, and the advance in wages, the property has been kept in good order; all necessary fixed charges and operating expenses have been paid out of the current revenue; the sum of $2,846,186 has been set aside as a sinking fund reserve, renewal, etc.; $490,860 has been contributed to the relief of the rates, and the capital obligation has been reduced by $539,460. This is certainly a remarkable demonstration of what can be effected by intelligent and conservative and at the same time progressive municipal management.

It will be seen that the average fare paid per passenger was only a trifle over 2 cts. Were five-cent fares the rule as in the United States, Liverpool would be reaping a great revenue from its street railway properties.

PLATE-GIRDER DECK BRIDGES on the Duluth & Iron Range Ry. have the girders spaced unusually far apart, 10 ft. The floor is of ties 10 × 12 ins., 12 ft. long, and spaced 14 ins. c. to c. The guard timbers are 10 × 12 ins. with their outer faces 10 ft. apart; these timbers are secured directly to the girder flanges by hook bolts. This construction, which has been adopted as standard by Mr. R. Angst, Chief Engineer, is estimated to cost about 6% more for steel and 84% more for the timber deck, than similar construction with the more usual spacing of 7 ft. 6 ins. for the girders. In a paper by Mr. W. H. Radcliffe in the "Technograph" (University of Illinois) this design is commented upon as follows:

The advantages of the wide spaced girders are: (A) Increased stability of the entire structure. (B) Increased safety in case of derailment of trains on the bridge, as it would be almost impossible for the trucks to ride over 10 × 12-in. guard rails anchored directly to the girders themselves. (C) In case of accident the disabled train is easily accessible and the wrecking crew has a much better opportunity to work around the train. This would operate to lessen the time of blockade, and consequently reduce the inconvenience to traffic. To offset the above we have an increased first cost of the structure and an increased cost of decking, whenever it has to be renewed.

REINFORCED CONCRETE TIES of peculiar design have been made by Mr. R. T. Mershon, C. E., Washington Heights, Chicago, and it is expected that they will be given a trial on the Pennsylvania Lines. The tie is 8 ft. 6 ins. long, 4 ins. wide on top, 9 ins. on the bottom and 6 ins. deep. On the top is a 4-in. steel channel or trough with flaring sides, with a cushion of hemp between it and the concrete, the channel being anchored to the concrete by three ¾-in. twisted bolts. The concrete has lengths of ¾-in. manila rope and layers of stout binder twine embedded in it, the purpose of this being to act as a bond in the concrete. Rods and wires may be used instead. The rails are held by clips with short bolts having their heads inside the steel channel, a 3-16-in. washer plate 24 × 3 ins. being placed under each rail seat and secured by the two bolts. The weight is about 400 lbs., and it is estimated that the ties could be made in quantities for about $1 to $1.50 per tie.

A MOUNTAIN ELEVATOR has recently been built to give more convenient access to a picturesque cliff of the Bürgenstock, a mountain on the northwestern side of the Lake of Luzerne, Switzerland. The elevator has a lift of 495 ft. between upper and lower landings, of which height the lower 143 ft. are in rock shaft while the upper 352 ft. are in a steel tower. The elevator shaft has a cross section 6½ ft. square. The steel structure, a square four-leg braced framework of constant width throughout its height, is anchored to the cliff-wall, which is nowhere more than 35 ft. back, at intervals of 60 to 75 ft. by stiff anchorages. The anchorage bents have two hinges in each leg, in horizontal lines, to allow free vertical expansion and contraction of the tower. The elevator car is designed for a live load of about 1,200 lbs., and is completely housed in with zinc-sheeted wooden housing for protection of the passengers from the weather. The hoisting motor is designed to give a lifting speed of 200 ft. per min. It is a bipolar shunt motor of 15 HP., running at 900 r. p. m. supplied with current from a 1,200-volt trolley-line network; double reduction gearing, with herringbone teeth, drives a drum 6½ ft. in diameter carrying two ⅝-in. plow-steel cables, each with 6 × 19 wires of 1 mm. diameter. The elevator car is carried on one cable, the counterweight on the other.

A number of safety devices guards the operation of the elevator: a speed governor set at 16⅔% excess speed trips the main current circuit-breaker, which action not only cuts off the power but also applies a brake to the motor shaft; a second speed governor, set at 33⅓% excess speed is arranged to set gripping jaws on the (wooden) elevator guides; a slack-cable indicator trips the main circuit breaker; limit stops shift the controller to zero when the car nears either end of its travel; a special switch in the main circuit is provided, to be operated either by the car or by the counterweights as soon as the normal travel is exceeded; a hand brake on the rope drum is provided, to be operated by hand, for example in case of a gear fracture, and the brake handle is connected with the last-mentioned switch so as to also open the motor circuit and apply the motor brake; a no-voltage relay in the main circuit applies the motor brake in case there is a cessation in the current supply; lastly, the guide brake jaws can be operated manually by the elevator attendant in the car. The car is fitted with a crank mechanism arranged to raise the car to the top, manually, when the guide-jaws have been set and the car stopped. A height-indicator in the motor-room enables the operator to see at all times the position of the car.

The complete elevator, described in the "Schweizerische Bauzeitung" of Oct. 7, 1905, was built by C. Wüst & Co., of Zürich, and the tower was constructed by Löhle & Co., of Kloten.

PERSONALS.

Mr. John C. Graves, of Buffalo, N. Y., has been appointed Secretary of the New York State Water Supply Commission.

Mr. W. A. Shaw, Assistant Engineer of Intercepting Sewers, Chicago, has been appointed Engineer of the Water Department.

Mr. Joel G. Berry, Engineer to the Park Commission of Denver, Colo., has been promoted to the position of General Superintendent of all public parks of that city.

Mr. A. C. Dennis has been appointed Division Engineer of the Prairie East Division of the Grand Trunk Pacific Ry., with headquarters at Winnipeg, Man., succeeding E. R. McNeill, deceased.

Mr. John Ericson, City Engineer of Chicago, has resigned from active work, but has been appointed Consulting Engineer by the Commissioner of Public Works so that his services may still be available to the city.

Mr. J. P. Spindle, of Washington, D. C., formerly Engineer of the Honolulu Rapid Transit Co., has been appointed Engineer of the Koolau R. R. Co., and will sail on the "Mongolia" from San Francisco, Nov. 15.

Mr. Charles C. Remsen, of the Sprague Electric Co., and Miss Mary Edna Fiske were married Nov. 1 in St. Paul's Methodist Episcopal Church, Newark, N. J. Mr. and Mrs. Remsen have gone South on their wedding trip.

Mr. T. S. Cafferty has been appointed Inspector of Track and Roadway on the Atchison, Topeka & Santa Fe Ry., with office at Topeka, Kan. Mr. D. Orr has been appointed to the same position on another division, with office at La Junta, Colo.

Mr. Chas. H. Miller has resigned his position as Engineer with McClintic-Marshall Construction Co., at Pittsburg, Pa., and has accepted a position as Engineer of River Protection for the Missouri Pacific Ry., with headquarters at St. Louis, Mo.

At a recent meeting of the Board of Trustees of Rutgers College, the resignation of Dr. Austin Scott, as President of that institution, was accepted. Dr. Scott, who is now on a year's leave of absence, will continue to fill the Voorhees Chair of History and Political Science.

Mr. Charles L. Ruffin, Assistant Roadmaster on the Richmond, Fredericksburg & Potomac R. R., with headquarters at Fredericksburg, Va., has resigned his position in order to accept the position of Division Engineer on the South & Western Ry., which is now being built in Southwest Virginia.

Mr. T. C. B. Snell, for the past seven years Chief Civil Engineer for the Hartford Street Ry. Co. of Hartford, Conn., has accepted a position with Ford, Bacon & Davis, Engineers, of New York City, and is stationed at Memphis, Tenn., where they are reconstructing and extending the street railway system.

Mr. Robert S. Edwards, formerly chemist with the Rockland-Rockport Lime Co., of Rockland, Me., has associated himself with Mr. Herbert L. Sherman, Analytical Chemist and Cement Expert, at 220 Devonshire St., Boston, Mass. The firm will continue to specialize in the testing of cement, lime and building materials.

Mr. A. P. Peck, Assoc. Am. Inst. E. E., formerly an electrical sales agent for the National Electric Co., has joined the Allis-Chalmers Co., and will hereafter be connected with the New York office of that company. He will travel throughout the New York district, giving attention particularly to the sale of power and electrical machinery.

Mr. C. W. A. Koelkebeck, Mechanical Engineer, for the past four years with The Garrett-Cromwell Engineering Co. and for ten years previous with Julian Kennedy, has joined the engineering staff of The Wellman-Seaver-Morgan Co., Cleveland, O., where his attention will be given to blast furnace, steel plant and rolling mill construction, etc.

Mr. John Meighs, U. S. Assistant Engineer in charge of the highway bridge over the Potomac River, Washington, D. C., has resigned and accepted the position of Engineer, Penn Bridge Co., in charge of the construction of the Anacostia Bridge, Piney Branch Bridge and bridge over the Tidal Basin, Washington. His offices will be in the Colorado Building, Washington.

Charles Francis, alias Chas. de Nevers, who, by falsely representing himself to be a Member of the American Society of Civil Engineers, obtained loans of money from various engineers in New York city a few months ago, has been sentenced to five years in Sing Sing Prison. The false information furnished by this man to Engineering News, and published in our last volume, was corrected in our issue of Sept. 14, p. 276.

Mr. Virgil G. Bogue, M. Am. Soc. C. E., vice-President and General Manager Western Pacific Ry., has announced the following appointments for that road: Mr. H. M. McCartney, principal Assistant Engineer, with office at San Francisco, Cal.; Mr. John T. Williams, Division Engineer at Oakland, Cal.; Mr. Emery Oliver, Division Engineer at Oroville, Cal.; Mr. James Q. Jamieson, Division Engineer, Elko, Nev.; Mr. Charles Harlowe, Division Engineer, Winnemucca, Nev.; Mr. T. J. Wyche, Division Engineer, Salt Lake City, Utah; Mr. J. C. Haveley, Chief Clerk Engineering Department, and Mr. J. B. Wallace, Engineer Right of Way, both at San Francisco.

Mr. R. E. Mathot, M. Inst. Mech. E., of Brussels, Belgium, who has a world-wide reputation in the field of gas engine design, arrived in the United States on Nov. 5, and will spend a month or more visiting the principal cities in connection with consultation work for various American gas engine manufacturers. He expects to visit Buffalo Nov. 11; Cleveland, Nov. 16; Chicago, Nov. 21; Cincinnati, Dec. 1, and Pittsburg, Dec. 6, returning to New York about Dec. 10. Mr. Mathot was the author of the extended paper on the design of large gas engines, presented before the British Institution of Mechanical Engineers last summer, and published in our issue of Aug. 31. Letters to Mr. Mathot during his stay in the United States may be addressed in care of the American Society of Mechanical Engineers, 12 W. 31st St., New York City, from whence they will be forwarded.

Changes in the management following the recent consolidation of the Erie R. R. with several other roads have been announced as follows: Mr. A. J. Stone, formerly General Superintendent of the Delaware & Hudson Co., has been appointed Assistant General Manager of the Erie, Cincinnati, Hamilton & Dayton and Chicago, Cincinnati & Louisville Roads; Mr. E. A. Williams, now Assistant General Manager of the Erie, has been appointed General Mechanical Superintendent of Erie, Cincinnati, Hamilton & Dayton and Chicago, Cincinnati & Louisville, and Pere Marquette Roads; Mr. R. H. Bowron, General Manager of the Cincinnati, Hamilton & Dayton, will succeed George Van Keuren, as General Superintendent of the Erie Division, extending from New York to Salamanca and Buffalo; the jurisdiction of Mr. J. C. Stuart, General Manager of the Erie R. R., has been extended over the Cincinnati, Hamilton & Dayton and Chicago, Cincinnati & Louisville Roads.

Mr. L. B. Stillwell, M. Am. Inst. E. E., has been appointed Consulting Electrical Engineer of the New York, Westchester & Boston Ry. Mr. H. S. Putnam, Assoc. Am. Inst. E. E., has been appointed Electrical Engineer of that road, and has opened offices at 30 Broad St., New York City, where the staff of this department will be located. Mr. Stillwell began the practice of electrical engineering with the Westinghouse Co., and was afterwards Chief Engineer, Niagara Power Co. He has acted as consulting engineer for a number of projects among them the electrification of the Manhattan elevated lines and entire planning of the New York subway electrical equipment; at present he is Electrical Engineer of the Interborough R. R., and Consulting Engineer of the Hudson Tunnel Co., in addition to his duties as Consulting Engineer of the New York, Westchester & Boston Ry. Co. Mr. Putnam is a graduate of Rose Polytechnic Institute; since graduation he was engaged with the Thompson-Houston Electric Co., Boston; Brush Carbon Works, Cleveland; Consulting Electrical Engineer, Chicago; Consulting Engineer associated with Horatio A. Foster, Philadelphia, and since 1902 with Mr. Lewis P. Stillwell in Interborough and other work in New York.

Obituary.

Edwin I. Kilburn, a contractor, of Bellows Falls, Vt., was killed Nov. 1 by a fall from the roof of the new town hall at Wallingford, Vt.

Lorenzo Bull, one of the builders of the Chicago, Burlington & Quincy R. R., died Nov. 2, at Quincy, Ill., aged 87 years. He was one of the original incorporators of the Union Pacific R. R., and was the owner of the water-works at Quincy, Ill., for 30 years.

Louis T. Levy, an architect with offices in New York City, was killed recently in San Francisco, Cal., by a fall from the window of the house in which he was stopping. During the past summer he had been in San Francisco assisting Mr. D. H. Burnham in plans for the beautification of the city.

Major John Bryne died Oct. 31, while visiting at the home of James Clark, Quaker Ridge, Larchmont, N. J. For over 20 years Major Bryne was identified with the railroad operations of the late C. P. Huntington. At one time he was President of the Pittsburg, Shawmut & Northern R. R. and of the Shawmut Mining Co.

George C. Bailey, Secretary and Treasurer and Chicago Manager of the John A. Roebling Sons Co., died Oct. 28 at his residence, 5224 Jefferson Ave., Chicago, after a year's illness. Mr. Bailey was born in Lambertville, N. J., in 1843. He was connected with the Roebling Co. in New York for eight years, and in 1885 came to Chicago to establish the western branch of the business.

George W. Enos, a civil engineer employed by the Turner Construction Co., 11 Broadway, New York, was instantly killed last week by being struck by a train on the elevated road. He was standing on Grand St. station platform and fell directly in front of a northbound train. He was about 30 years old and was a graduate of Cornell University. He resided at 166 Remsen St., Brooklyn, N. Y.

Noel Mariotte, a civil engineer well known in California, died Oct. 27 in Oakland, aged 76. Mr. Mariotte was a man of many attainments, an engineer of the old French school, of a most liberal education and of considerable experience. Only his great modesty kept him from the front ranks of the Pacific Coast engineers. He had seen service in Cuba, in Central America and in many States of the Union, but finally made California his home. For the last 17 years of his life he was the Chief Draftsman in the United States Engineer Office in San Francisco, engaged in fortification works of the harbor. He served under many engineer officers, and those who read this notice of his death will have a kind word and a kind thought for the man who served them so faithfully.

ENGINEERING SOCIETIES.

COMING MEETINGS.

MAINTENANCE OF WAY MASTER PAINTERS' ASSOCIATION.
Nov. 13, 14. Annual meeting at Cincinnati, O. Secy., H. J. Schnell, 100 William St., New York, N. Y.

AMERICAN MINING CONGRESS.
Nov. 14 to 18. Congress at El Paso, Tex. Secy., J. F. Calbreath, Jr., Denver, Colo.

SOCIETY OF NAVAL ARCHITECTS AND MARINE ENGINEERS.
Nov. 16, 17. Annual general meeting at New York, N. Y. Secy., Wm. J. Baxter, 12 West 31st St., New York, N. Y.

ASSOCIATION OF TRANSPORTATION AND CAR ACCOUNTING OFFICERS.
Nov. 21. Annual convention at St. Louis, Mo. Secy., G. P. Conard, 24 Park Place, New York, N. Y.

AMERICAN SOCIETY OF REFRIGERATING ENGINEERS.
Dec. 4 and 5. Annual meeting at New York, N. Y. Secy., W. H. Ross, 258 Broadway, New York, N. Y.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Dec. 5-8. Annual meeting at New York, N. Y. Secy., F. R. Hutton, 12 West 31st St., New York.

MICHIGAN ENGINEERING SOCIETY.
Jan. 9, 10, 1906. Annual convention at Lansing, Mich. Secy., F. Hodgman, Climax, Mich.

NATIONAL ASSOCIATION OF CEMENT USERS.
Jan. 9 to 12, 1906. Annual convention at Milwaukee, Wis. Secy., C. C. Brown, Commercial Club Bldg., Indianapolis, Ind.

NEW ENGLAND WATER-WORKS ASSOCIATION.
Jan. 10. Annual meeting. Secy., Willard Kent, Narragansett Pier, R. I.

NEW ENGLAND WATER-WORKS ASSOCIATION.—The Committee on Nominations has reported the following, which will be voted on by letter ballot before the annual meeting held in January: For President, Prof. Wm. T. Sedgwick (Boston, Mass.); for Vice-Presidents, Messrs. J. Waldo Smith (New York, N. Y.), C. M. Lunt (Lewiston, Me.), F. A. Andrews (Nashua, N. H.), J. C. Chase (Derry, N. H.), F. W. Gow (Medford, Mass.), and J. M. Birmingham (Hartford, Conn.); for Secretary, Mr. Willard Kent (Narragansett Pier, R. I.); for Treasurer, Mr. L. M. Bancroft (Reading, Mass.); for Editor, Mr. C. M. Sherman (Boston, Mass.); for Finance Committee, Messrs. H. L. Thomas (Hingham, Mass.), Wm. E. Maybury (Braintree, Mass.), and A. D. Marble (Lawrence, Mass.); for Executive Committee, Messrs. F. E. Merrill (Somerville, Mass.), G. A. Stacy (Boston, Mass.), and J. L. Tighe (Holyoke, Mass.)

APPALACHIAN ENGINEERING ASSOCIATION.—The Appalachian Engineering Association held its regular quarterly meeting at the Bluefield Inn, Bluefield, W. Va., on Saturday evening, November 4th. After the transaction of business and the election of new members, Mr. Howard B. Eavenson, Chief Engineer of the U. S. C. & C. Co., Gary, W. Va., read a paper on "Bee Hive Oven Construction," followed by Mr. H. C. Rowie, of Welch, W. Va., on the "Sixth Sense of Civil Engineering." A paper by Mr. C. C. Wentworth, Asst. Chief Engineer, N. & W. Ry., was then read, on the supject of the "Slide Rule," and Dr. Henry M. Payne, presented a paper and map on the "Development of the Tug River Coal Field 1900-1905." After a general discussion the meeting adjourned to hold its annual meeting at Williamson, W. Va., on February 3, 1906, at 1:30 p. m. Secy., H. M. Payne, Lock Drawer P, Williamson, W. Va.

TECHNICAL PUBLICITY ASSOCIATION.—At a meeting and banquet of the Technical Publicity Association, held at the Aldine Club, New York, Friday evening, Nov. 3, the following officers were elected: President, C. B. Morse, Ingersoll-Rand Drill Co.; First Vice-President, H. M. Cleaver, Niles-Bement-Pond Co.; Second Vice-President, F. H. Gale, General Electric Co.; Secretary, Rodman Gilder, Crocker-Wheeler Company.; Treasurer, H. M. Davis, Sprague Electric Co.; members of Executive Committee, Graham Smith, Westinghouse Companies, and Chas. M. Manfred, Johns-Manville Co. Mr. H. M. Davis addressed the association on "The Advertising Appropriation." An informal discussion followed, in which the members exchanged views on the disposition of advertising appropriations, the relative amount that should be spent in magazine and circular advertising, the relation between the advertising appropriation and the volume of business, etc.

NATIONAL ASSOCIATION OF CEMENT USERS.—The coming convention of the association will be held in the Armory, Milwaukee, Wis., on Jan. 9 to 12. A large exhibit room will be available for exhibits of materials and appliances. The program of papers for the convention is not yet completed, but the following is a list of those papers which have been definitely promised:

"Air Tamping of Concrete Blocks and Conveying of Blocks," J. P. Sherer, Milwaukee, Wis.; "Observations on the Testing and Use of Portland and Natural Cements," E. S. Larned, Boston, Mass.; "Building Regulations Regarding Concrete Blocks," Will J. Scoutt, Chicago, Ill.; "Concrete as a Fireproof Material," E. T. Cairns, Chicago, Ill.; "The Use of Cement and Concrete for Farm Purposes," S. M. Woodward, U. S. Department of Agriculture, Washington, D. C.; "Waterproofing," J. L. Mothershead, Jr., Indianapolis, Ind.; "Causes of Failures in the Concrete Block Business," O. U. Miracle, Minneapolis, Minn.; "Reinforced Concrete," C. A. P. Turner, Minneapolis, Minn.

Further information about the convention, and information about the exhibition, may be obtained from the Secretary, C. C. Brown, Commercial Club Bldg., Indianapolis, Ind.

WESTERN SOCIETY OF ENGINEERS.—In October a party of members went to Champaign to attend the ceremonies of the installation of Dr. James as President of the University of Illinois. A special sleeping car was engaged for the trip.

At a meeting held in the Society's rooms at Chicago on Nov. 1 Mr. T. W. Snow presented a paper, "The Softening of Water for Locomotive Boilers," illustrated by views of apparatus and diagrams showing the proportions of scale-producing matter in various waters before and after treatment. Special reference was made to the great quantities of water requiring to be treated for this purpose, rendering any general use of boiler compounds out of the question. The cost of treatment varies from ½ ct. to 2½ cts. per 1,000 gallons, depending upon the quality of the water.

In the discussion, Mr. G. M. Davidson, Chemist and Engineer of Tests of the Chicago & Northwestern Ry., stated that the results obtained amply warranted the expense of installing water softening plants. With the use of treated water, boiler repairs are greatly reduced, there are fewer engine failures and delays on the road, more work can be done with less fuel and fewer engines, and the engines can work for a longer time before going to the shop for repairs.

AMERICAN SOCIETY OF CIVIL ENGINEERS.—A subject of considerable interest to structural engineers came before the last meeting of the society in a paper by Mr. E. F. Jonson, under the title "The Theory of Frameworks with Rectangular Panels, and its Application to Buildings which have to Resist Wind." The practice which in recent years has become almost universal, namely, to avoid the use of diagonals as windbraces in the frames of tier-buildings and to use instead the bending resistance of stiff riveted joints, received in this paper its first tacit recognition in engineering literature. Ordinarily, such frames are designed by assuming that the wind shear on any one bent divides itself equally among the columns, or the moment divides equally, or the moment divides in proportion to the stiffness of the several columns. Such assumptions are purely arbitrary, and as the frame is in reality a statically indeterminate frame, an exact solution is possible. The author develops, in relatively simple manner, the theoretical expressions which represent the interaction of members in rigid rectangular frames, and shows how the true stresses in such frames may be found by solving systems of simultaneous equations. The simplification is used of considering the several columns in a bent to maintain the same relative moments of inertia in successive stories, and the further simplification of assuming the points of contraflexure to be at the middle points of the story heights. At the close the author suggests that for preliminary design (which is essential to the complete calculation) the wind moment in an outside column may be taken as 75% of the moment in an inside column. In discussion, Mr. Forchheimer questioned one of the fundamental assumptions contained in the author's development, the assumption that the joints of the framework are rigid, that is, permit no change of the angle between the end tangents of members meeting at that joint. This assumption is open to no question when a web-gusset connection is used, but in case of the ordinary end framing-angle connection it is not correct, since the outstanding legs of the angles deflect as cantilevers. The speaker stated how this error can be allowed for, without material complication of the mathematical work. The speaker suggested also, that while gusset connections are desirable on outside columns, they are not desirable on inside columns, since they must there take a moment (or load) greater than the center moment of the floor beams. In most cases it is impracticable to reinforce such joints sufficiently to enable them to carry this great moment, and end framing connections are therefore preferable for the inside columns in such cases.

CONCRETE ASSOCIATION.—A conference of men interested in concrete construction in New York City met on the evening of Thursday, Nov. 2, at the rooms of the Building Trades Employers Association, 1123 Broadway, New York, and took steps toward the formation of a business organization in the interests of concrete work. A call for the conference had been issued by Mr. R. F. Tucker, acting for a party of a dozen or more who had met and discussed the subject some time previously. Some fifty cement and concrete men gathered in response to the call. Mr. Tucker, calling the assemblage to order, stated briefly the purpose of the meeting. The greatly increasing diversity in the uses of concrete, especially the important part it has come to play in building construction, have in late years created a strong class sentiment, a community of interest, among concrete men. Correspondingly, there has been increasing need for cooperative or class action, to meet common difficulties against which individual action makes but slow headway. One of the greatest of these difficulties, in New York City, is the ultra-conservative stand of the Building Department toward concrete as a building material; beginning with the days when no form of concrete floor construction was permitted in New York City, and the subsequent period when one or two types of concrete floor construction monopolized the Department's approval (outside of brick or tile arch construction), the attitude of the Department has always been far more conservative than the partisans of concrete and reinforced concrete consider justifiable. At the present time floor and partition constructions have won a reasonable degree of standing, as any type of construction will be approved after standing a specified fire-water-load test carried out at the expense of the applicant; but other applications of reinforced concrete, and many suitable applications of plain concrete, are still in as unfavorable a position as they were ten years ago. The position of the Building Department is almost duplicated in the stand of the Board of Fire Underwriters, who, according to the concrete people, set themselves fixedly against recognition of the structural and fireproof value of plain or reinforced concrete. Against these obstacles to the utilization of concrete in construction only a well-organized and aggressive business league can make profitable progress. Such a league, moreover, will have large possibilities in promoting the spread of concrete lore and making concrete more popular. It can also do service in dealing with labor questions. Much of the concrete work hitherto has been done mainly with unskilled labor, and quite successfully. It may be expected, however, that labor organizations will endeavor to bring this class of work under their control, in which case the individual contractor will be far less able to guard his interests properly than would a contractors' league. There are other distinctive functions which such a league might appropriately perform, but those indicated will sufficiently justify the efforts toward organization.

Under the chairmanship of Mr. Merrill Watson (Expanded Metal Engineering Co.), the meeting proceeded to elect officers, following a scheme drawn up by a committee delegated by the earlier meeting already referred to. The following were chosen: President, Mr. Ross F. Tucker (Tucker & Vinton, Inc.); First Vice-President, in charge of Legislation and Insurance, Mr. H. C. Turner (Turner Construction Co.); Second Vice-President, in charge of Membership, Mr. H. C. Miller (H. C. Miller & Co.); Third Vice-President, in charge of Exhibits, Mr. W. W. Benson (Standard Stone Co.); Secretary, Mr. T. G. Barr (Vulcanite Portland Cement Co.); Treasurer, Mr. Ronald Taylor.

The recommendations of the preliminary committee suggested that membership would be drawn from, roughly, five classes of men, concerned respectively with Paving, Fireproofing, Reinforced Concrete, Manufacture of Materials and Allied Arts. A permanent exhibition, for the education of contractors and public, was suggested, and will probably be made a feature of the organization's work. It is likely that the expenses of the association will be rather heavy, and initiation fees and dues consequently high. Mr. J. O. Ellinger (Reinforced Cement Construction Co.) therefore made a plea for provision for the young engineer members of the profession, who while valuable as members of the association would not be able to pay the regular dues. This matter, however, and also that of Scope (which aroused some discussion on whether membership should be local or wider), will be considered by a committee on Permanent Organization, appointed to report at the next meeting. The association will have its second meeting, at the same place as the first, on the evening of Nov. 16, 1905.